

**Assessment of non-proliferation regime to
establish regulatory framework for the front-end
of the nuclear fuel cycle in Africa**

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ABSTRACT

This is a research based project to support the Non-Proliferation regime by investigating ideas on how to improve assurances that the front end of the nuclear fuel cycle (NFC) on the African continent is not used to support non-peaceful purposes.

The front end of the nuclear fuel cycle consists of those stages of the fuel cycle before the utilization of nuclear fuel (uranium) in a nuclear reactor. Apart from South Africa, no other African country is operating nuclear power plants. The part of the nuclear fuel cycle that is relevant to all African countries with uranium resources are uranium mining and uranium milling.

The stages of the nuclear fuel cycle covered in this project are therefore, uranium mining and uranium ore concentration (milling). Transportation of uranium ore concentrate is also considered.

Nuclear safeguards is the principal technical means by which proliferation aspects of the nuclear fuel cycle are addressed at both the international and national levels. This project reviews and assesses the safeguards measures currently in place, in order to identify weaknesses; with a view of strengthening the presently deployed measures.

Additionally, the project examines the nuclear non-proliferation relevant legal frameworks in force in African States, the project also looks at nuclear security, other verification regimes (such as those under the CTBTO, EURATOM Treaty, JCPOA and the OPCW), other nuclear weapons free zone treaties (Tlatelolco), as well as verification and control in the diamond mining and processing industry; in order to identify best practices that could be adopted and adapted to strengthen safeguards implementation at the front end of the nuclear fuel cycle. The ultimate objective of the project, as previously indicated, is to develop ideas on how to enhance the non-proliferation stewardship of the front end of the nuclear fuel cycle in general and on the African continent in particular.

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ACRONYMS & DEFINATIONS

ACRONYMS

ABACC	Argentina Brazil Accounting Control of Nuclear Material
AFCONE	African Commission of Nuclear Energy
AP	Additional Protocol
CSA	Comprehensive Safeguards Agreement
CTBT	Comprehensive Test Ban Treaty
CTBTO	Comprehensive Test Ban Treaty
CWC	Chemical Weapons Convention
EURATOM	European Atomic Energy Community
IAEA	International Atomic Energy Agency
JCPOA	Joint Comprehensive Plan of Action
INFCIRC	Information Circular
ISA	Item Specific Agreement
KPCS	Kimberley Process Certification Scheme
NECSA	South African Nuclear Energy Corporation.
FNRB	Forum for Nuclear Regulatory Bodies in Africa
NFC	Nuclear Fuel Cycle
NNWS	Non-Nuclear Weapon State
NPT	Nuclear Proliferation Treaty
NWFZ	Nuclear Weapons Free Zone
NWS	Nuclear Weapon State
OPANAL	Organismo para la Proscpción de las ArmasNuclearesen la América Latina y el Caribe), in english, its name is the Agency for the Prohibition of Nuclear Weapons in Latin America and the Caribbean.
OPCW	Organization for the Prohibition of Chemical Weapons
SQP	Small Quantity Protocol
SSAC	State System of Accounting and Control of nuclear material
TNT	Trinitrotoluene
UOC	Uranium Ore Concentrate
VOA	Voluntary Offer Agreement

DEFINITIONS

- 1 **Africa Nuclear Weapons Free Zone Treaty (Pelindaba Treaty)** - the treaty establishing a nuclear –weapon-free zone in Africa. The Treaty requires its parties not to conduct research on, develop, manufacture, stockpile, acquire, possess or have control of any nuclear explosive device anywhere, and to prohibit the stationing or testing of any such device. Each State party to the Treaty undertakes to conclude a comprehensive safeguards agreement with the IAEA required in connection with the NPT.

- 2 **Conversion** –The chemical process involved in transforming the chemical composition nuclear material to the chemical forms, required by the various stages of the nuclear fuel cycle.
Conversion 1: refers to the processing of natural uranium; while;
Conversion 2: refers to the processing of enriched uranium.

- 3 **Feed Material**- nuclear material introduced at the start of a process operation, e.g. UF_6 as the feed to an enrichment process or to a UO_2 conversion process, or UO_2 as the feed to a fuel fabrication operation.

- 4 **High Enriched Uranium (HEU)** - uranium containing 20% or more of the isotope ^{235}U . HEU is considered a special fissionable material and a direct use material.

- 5 **INFCIRC/153-type safeguards agreement**- an agreement concluded on the basis of [153]. Such agreements include all types of comprehensive safeguards agreement and voluntary agreement.

- 6 **INFCIRC/540**- a protocol additional to a safeguards agreement(s) concluded between the IAEA and a State, or group of states, following the provisions of the Model Additional Protocol, to provide the IAEA with expanded access to information of locations.

- 7 **Low Enriched Uranium (LEU-)** enriched uranium containing less than 20% of the isotope ^{235}U . LEU is considered a special fissionable material and an indirect use material.
- 8 **NWS** (Nuclear Weapons State): Article IX.3 of the NPT defines a nuclear weapon State as one which manufactured and exploded a nuclear weapon or other nuclear explosive device prior to 1 January 1967. There are five such States: China, France, the Russian Federation (the Soviet Union when the Treaty entered into force), the United Kingdom and the United States of America.
- 9 **Non-Nuclear Weapons States (NNWS)** – NNWS under the NPT are States that had not exploded or tested a nuclear explosive device prior to 1 January 1967.
- 10 **Non-Proliferation Treaty (NPT)** - The full name of the NPT is the Treaty on the Non-Proliferation of Nuclear Weapons. The Treaty was opened for signature in 1968, and entered into force in 1970. In 1995, the Treaty was extended indefinitely. The NPT is the fundamental legal instrument through which nuclear materials are controlled around the world, including on the African continent.
- 11 **Nuclear Fuel Cycle (NFC)-** a system of nuclear installations and activities interconnected by streams of nuclear material The characteristics of the fuel cycle may vary widely from State to State, from a single reactor supplied from abroad with fuel , to a fully developed system. Such a system my consist of uranium mines and concentration (ore processing)plants , thorium concentration plants, conversion plants, enrichment (isotope separation)plants, fuel fabrication plants, reactors, spent fuel reprocessing plants and associated storage installations.
- 12 **Nuclear material-** means any source or special fissionable material as defined in Article XX of the IAEA statute. The term source material shall not be interpreted as applying to ore or ore residue.

- 13 **Safeguards Regulatory Authority (SRA)** - is a public authority or government agency responsible for exercising autonomous authority over safeguards implementation within State as a whole in a regulatory capacity. It deals in the area of administrative law, regulation or rule making. They are usually part of the executive branch of the government, and they have statutory authority to perform their functions with oversight from the legislative branch.
- 14 **Short Notice Random Inspection (SNRI)** - an inspection performed both on short notice and randomly. SNRIs are part of a safeguards approach developed for low enriched uranium fuel fabrication plants subject to safeguards, in order to provide improved coverage of domestic transfers of nuclear material. SNRIs may also be used at other facility types where the safeguard approach calls for unpredictably scheduled short notice inspections.
- 15 **Source Material-** uranium containing the mixture of isotopes occurring in nature; uranium depleted in the isotope ^{235}U ; thorium; any of the foregoing in the form of metal, alloy, chemical compound, or concentrate. The term source material shall not be interpreted as applying to ore or ore residue.
- 16 **Special fissionable material-** In general, an isotope or a mixture of isotopes capable of nuclear fission. Some fissionable materials are capable of fission only by sufficiently fast neutrons (e.g. neutrons of a kinetic energy above 1 MeV). Isotopes that undergo fission by neutrons of all energies, including slow (thermal) neutrons, are usually referred to as fissile materials or fissile isotopes. For example, isotopes ^{233}U , ^{235}U , ^{239}Pu and ^{241}Pu are referred to as both fissionable and fissile, while ^{238}U and ^{240}Pu are fissionable but not fissile.
- 17 **State System for Accounting and Control of nuclear material (SSAC)-** organizational arrangements at the national level which may have both a national objective to account for and control nuclear material in the State and an international objective to provide the basis for the application of IAEA safeguards under an agreement between the State and the IAEA.

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Uranium- naturally occurring radioactive element with atomic number 92 and symbol U. Natural uranium contains isotopes 234, 235, and 238; uranium isotopes 232, 233 and 236 are produced by transmutation.

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CHAPTER 1 INTRODUCTION

This is a research based project to support the Non-Proliferation regime by investigating ideas on how to improve assurances that the front end of the nuclear fuel cycle (NFC) is not used to support non-peaceful purposes.

The front end of the nuclear fuel cycle consists of those stages of the fuel cycle before the utilization of nuclear fuel (uranium) in a nuclear reactor. Apart from South Africa, no other African country is operating nuclear power plants. The part of the nuclear fuel cycle that is relevant to all African countries with uranium resources are Uranium mining and Uranium milling.

The research and analysis will therefore focus on: - Uranium mining; - Uranium milling; - Transportation of uranium ore concentrates (UOC).

These front-end stages of the nuclear fuel cycle are not fully covered by presently deployed safeguards accountancy measures – both at the national and international levels. The front end of the NFC is therefore more vulnerable to misuse in support of potential proliferation threats. In fact, data reviewed for the period from 1990 to 2015(1) shows that incidents involving illicit possession and/or trade in enriched uranium are on the decline, while incidents involving uranium ore concentrate (yellowcake), particularly in Africa, have increased.

This project will explore ideas on technical means, as well as domestic, regional and multilateral non-proliferation means to address the situation.

This will be accomplished by:

i) Examining the safeguards system currently in place, in order to identify weaknesses, if any, with a view of finding solutions to offset the weaknesses. International safeguards are administered by the IAEA on the basis of safeguards agreements concluded by States with the IAEA. However, the IAEA implements safeguards in cooperation with the State – Paragraph 7 of the model safeguards agreement (INFCIRC/153) requires the State to establish and maintain a State System of Accounting for and Control (SSAC) of all nuclear material subject to safeguards under the Agreement.

Weaknesses and/or challenges in the current safeguards system will be ascertained via a critical review of the provisions of the safeguards agreement, and of the nuclear regulatory framework of the State (in which the SSAC operates).

ii) Examining the nuclear non-proliferation relevant legal frameworks in force in African States, nuclear security, other verification regimes (such as those under the CTBTO, EURATOM Treaty, JCPOA and the OPCW), other nuclear weapons free zone treaties (Tlatelolco), as well as verification and control in the diamond mining and processing industry; in order to identify best practices that could be adopted and adapted to strengthen safeguards implementation at the front end of the nuclear fuel cycle. Like Uranium, diamond is a strategic mineral that is subject to control measures. The strategic value of diamonds are mostly in their economic value as well as in concerns about diamonds being used to finance malicious acts and conflicts; while the strategic value of uranium is mostly in its application in nuclear weapons. However, the two minerals require similar control and monitoring mechanisms by their respective industries.

To illustrate the assessments, this project will use as examples, African countries that meet at least one of the following criteria (See Annex 1 and figures 1&2):

- Countries' having estimated recoverable uranium resources exceeding 1% of the world's known reserves.
- Countries with an annual uranium ore concentrate (yellow Cake) production exceeding 1% of the world's annual production; and/or
- Countries operating uranium mines, uranium mills or uranium conversion facilities.

For the purposes of this research project, countries meeting any of the above criteria will be considered as having significant uranium resources or activities.

1.1 Problem statement

The front-end stages of the nuclear fuel cycle are not covered with a high degree of confidence by the presently deployed safeguards model as implemented by the International Atomic Energy Agency (IAEA), and by national governments implementing safeguards based on the IAEA model (NPT safeguards). The lack of rigorous safeguards coverage introduces weaknesses in the control, auditing and monitoring of uranium ore concentrate, hence making the front end of the NFC vulnerable to misuse scenarios that support potential proliferation threats. Data reviewed for the period from 1990 to 2015 shows that incidents involving illicit possession and/or trade in enriched uranium are on the decline, while incidents involving uranium ore concentrate (yellowcake), particularly in Africa, have increased (1)

While the present safeguards model (NPT safeguards) puts more emphasis on fissile materials, it is increasingly becoming clear that yellowcake is a critical weak link in the system, and may be the preferred acquisition path to clandestine nuclear weapons programmes. This weakness is exacerbated by the fact that nuclear security and safeguards are not integrated to address control regime of UOC. Because of the intimate overlapping between safeguards and nuclear security from a non-proliferation point of view, the IAEA Department of Safeguards collaborates with the IAEA Department of Nuclear Security.

1.2 Research objective

The objective of this project is to develop regulatory frameworks on how to enhance the non-proliferation stewardship of the front end of the nuclear fuel cycle in general and on the African continent in particular. The performance targets of the project are to:

- Improve assurances that yellow cake is not used to support non-peaceful purposes;
- Implement nuclear accounting control measures in uranium mining and milling via the Pelindaba treaty administered by AFCONE;
- Establish AFCONE as a regional regulatory authority body to develop regulatory control of UOC in Africa, e.g. Import and export control, nuclear material accountancy, and control of transportation across national borders;
- Introduce new safeguards verification requirements to cover uranium mining and milling within the present safeguards framework without re-negotiation of safeguards agreements.

In order to achieve this objective, the project will:

- Assess the status of the front-end of the NFC on the African continent,
- Assess the currently deployed safeguards model in order to identify weaknesses and challenges. This assessment will be carried out by carrying out a critical review of the legal framework underpinning the current safeguards model – i.e. the non-proliferation treaty, safeguards agreements and additional protocols, and nuclear regulatory systems in African States.
- Assess whether there are opportunities within the current legal framework to mitigate these weaknesses and strengthen the system.
- Review and assess other verification regimes such as those under the EURATOM Treaty, the JCPOA, the Pelindaba Treaty, the TLATELOLCO treaty, CTBTO and the OPCW, as well as verification and control in the diamond mining and processing industry, in order to identify best practices that could be adopted and adapted to strengthening the current safeguards model as applied to the front end of the nuclear fuel cycle.
- Evaluate what other opportunities exist, outside NPT safeguards, for African countries to strengthen the non-proliferation control and monitoring of the front end of the nuclear fuel cycle.
- Provide a list of proposals/solutions on how to strengthen the non-proliferation control, verification and monitoring of the front end of the NFC in Africa.

1.3 Research methodology

The type of research that will be used in this study is based on review of legal frameworks, case studies, literature survey and analysis of all the information used from the point of view of the ultimate objective of this research paper – which is to make proposals on strengthening the verification and monitoring of the front end of the nuclear fuel cycle.

1.3.1 Legal framework

Legal Frameworks include the safeguards agreements concluded between the States and the IAEA, the pertinent non-proliferation related multilateral agreements, and the national laws and regulations which govern the exploration, exploitation, utilization and trade of uranium resources in African countries. The legal framework also includes regulatory authorities in the field of nuclear energy.

Understanding of the legal framework is important in this research because it defines the scope and boundaries of the solutions that may be prescribed for ensuring that the front end of the nuclear fuel cycle is not misused to further the acquisition of nuclear weapons.

Information on the existence or non-existence of a national regulatory authority, including the competence of such an authority is also important because it informs to what extent the solutions ultimately prescribed in the outputs of this research will rely on collaboration and cooperation with the State. Information on safeguards agreements and basic information about national regulatory frameworks was sourced from publicly accessible IAEA databases (2) Further information on national regulatory frameworks was obtained by reviewing government sites on the internet, independent open source information on the internet, and interviews/discussions with representatives of national regulatory authorities on the sidelines of the September 2016 IAEA General Conference.

1.3.2 Case studies

Case studies involve the evaluation of the present safeguards model that is used for the verification and monitoring of the nuclear fuel cycle – specifically international safeguards as implemented by the International Atomic Energy Agency (IAEA) and domestic safeguards as implemented by national governments within their territories. It is important to evaluate to what extent the current safeguards model is consistent with the legal frameworks. It is important because practical realization of the provisions of legal frameworks is usually the outcome of a negotiating process, and very often certain provisions are ignored, or watered down in how they are interpreted because of practical limitations and sometimes because of political factors.

For example, paragraph. 7 of the comprehensive safeguards agreement require the establishment of an SSAC; and for such a national system to be effective it should be independent organ of the government. The SSAC is usually not independent, and in some cases, like in South Africa, the regulatory body is NECSA that is also the owner and operator of the facilities inspected. As time passes, those practical constraints or political factors may no longer apply. So it was important in this research project to identify those solutions that could immediately be incorporated in the implementation of the safeguards model without any new negotiations.

The author of this research project is a safeguards inspector of the IAEA, and therefore is privy to how the IAEA implements international safeguards. Before joining the IAEA, the author of this research project was a national nuclear safeguards inspector for the South African government (NECSA); and through the position in NECSA interacted with staff from other African nuclear regulatory authorities in regional and international fora, as well as through direct electronic communication. Case Studies also cover aspects of Nuclear Security relevant to the monitoring and verification of the nuclear fuel cycle. Because of the intimate overlapping between safeguards and nuclear security from a non-proliferation point of view, the IAEA Department of Safeguards collaborates with the IAEA Department of Nuclear Security. Additionally, the author of this research project is familiar with nuclear security from the national point of view because NECSA where he worked before joining the IAEA was a national key point for nuclear security in South Africa.

Verification of a resource is not limited to safeguards and nuclear security; neither is it limited to the nuclear industry. In fact, nuclear material accountancy as applied in nuclear safeguards has its origins in banking and the finance industry. It was therefore necessary to do a literature survey of other systems involved in similar verification and monitoring in order to identify best practices that can be adopted and adapted to strengthen the non-proliferation control of the front end of the nuclear fuel cycle. Other verification systems covered in the literature survey include the EURATOM Treaty (formed to establish the European Atomic Energy Commission), the JCPOA (Agreement signed by five permanent members of IAEA board of governors and Germany and Iran for the implementation of IAEA safeguards in Iran), the Treaty of Pelindaba (weapons free zone treaty for the African Continent), the Tlatelolco Treaty (weapon free zone in the Latin America and Caribbean), the CTBTO (organization responsible to prohibit the testing of nuclear weapons), the OPCW (organization responsible to control and prohibit the use chemical weapons) and the diamond industry. The JCPOA was considered to be very relevant to the research, because the provisions of the JCPOA were mostly designed to address weaknesses in the present safeguards model – specifically the safeguards model (INFCIRC/153) that is based on the non-proliferation treaty.

CHAPTER 2 LITERATURE REVIEW

Safeguards¹ are currently the principal way that nuclear materials are controlled for the purpose of ensuring their exclusive peaceful uses. International safeguards are administered by the International Atomic Energy Agency (IAEA) via safeguards agreements that States conclude with the IAEA in accordance with the statutes of the IAEA. At the national level, domestic safeguards may be carried out by government authorities in accordance with their national laws, rules and regulations.

Three key aspects can be drawn from the above statement: 1) A verification model; 2) A verified resource & 3) Legal frameworks.

The problem statement of this research project specifies that uranium ore concentrates are resources that require verification and monitoring in accordance with certain legal frameworks, and that the verification models presently available for verifying uranium concentrate have certain weaknesses that require strengthening.

This research project therefore reviews and assesses the present verification models in terms of to what extent the measures and activities involved address the desired objectives, and also in terms of their fidelity to the legal frameworks underpinning them, in order to identify the weaknesses, classify them in the right context, and propose possible strengthening solutions.

However, limiting the scope of the research within the boundaries of the present safeguards model would be pandering to the status quo and counterproductive to the objectives of this project, which are to reveal new insights outside the existing framework. Hence it was decided, as indicated in the research methodology to review. 1) other verification frameworks, such as the EURATOM Treaty, the JCPOA, the Pelindaba Treaty, the TLATELOLCO treaty, the OPCW and the CTBTO; and 2) Other verified mineral resources such as Diamond; - in order to identify best practices that can be adopted and adapted to strengthen the non-proliferation effectiveness of the verification model for uranium ore concentrates.

It all starts here™

¹ Safeguards in this document refers to nuclear safeguards

2.1 Status of the front end of the nuclear fuel cycle on the African continent

Annex I provides information on uranium resources and production for African countries meeting the following criteria:

- Countries having estimated recoverable uranium resources exceeding 1% of the world's known reserves.
- Countries with an annual uranium ore concentrate (yellow Cake) production exceeding 1% of the world's annual production; and/or
- Countries operating uranium mines, uranium mills or uranium conversion facilities.

For the purposes of this research project, States meeting the above criteria will be considered as States with significant uranium resources. The States are Botswana, Central African Republic, Democratic Republic of Congo (DRC), Malawi, Namibia, Niger, South Africa, Zambia, and United Republic of Tanzania. See details of the is uranium resources and mining and milling the possess in Annex I

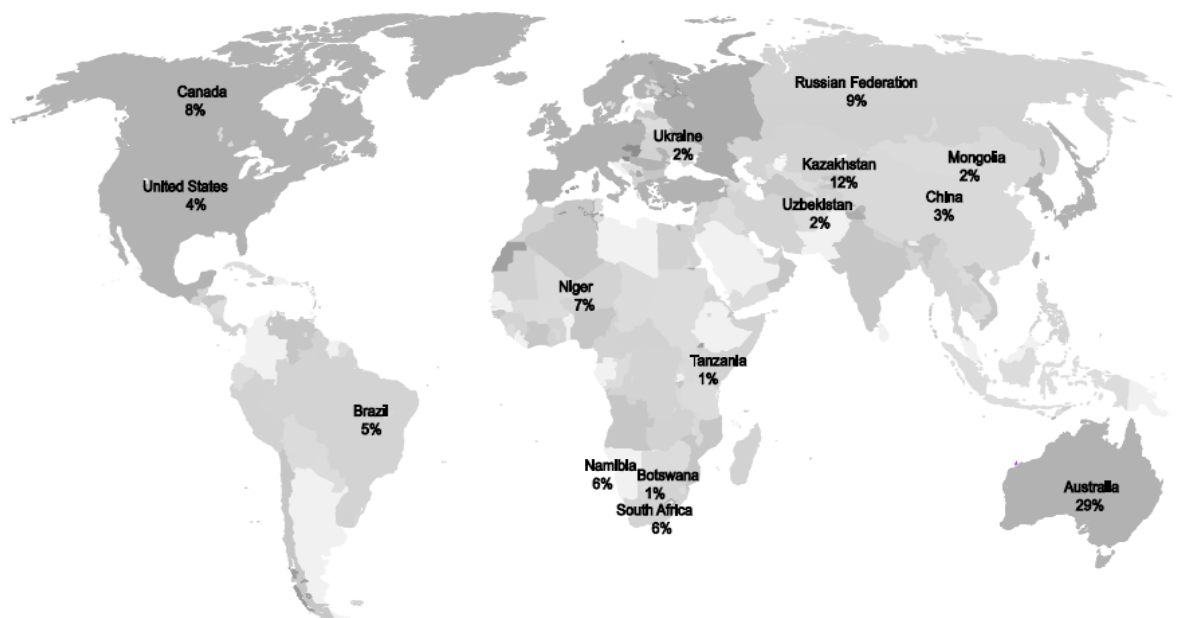


Figure 1: Global uranium resources with more than 1% share (3)

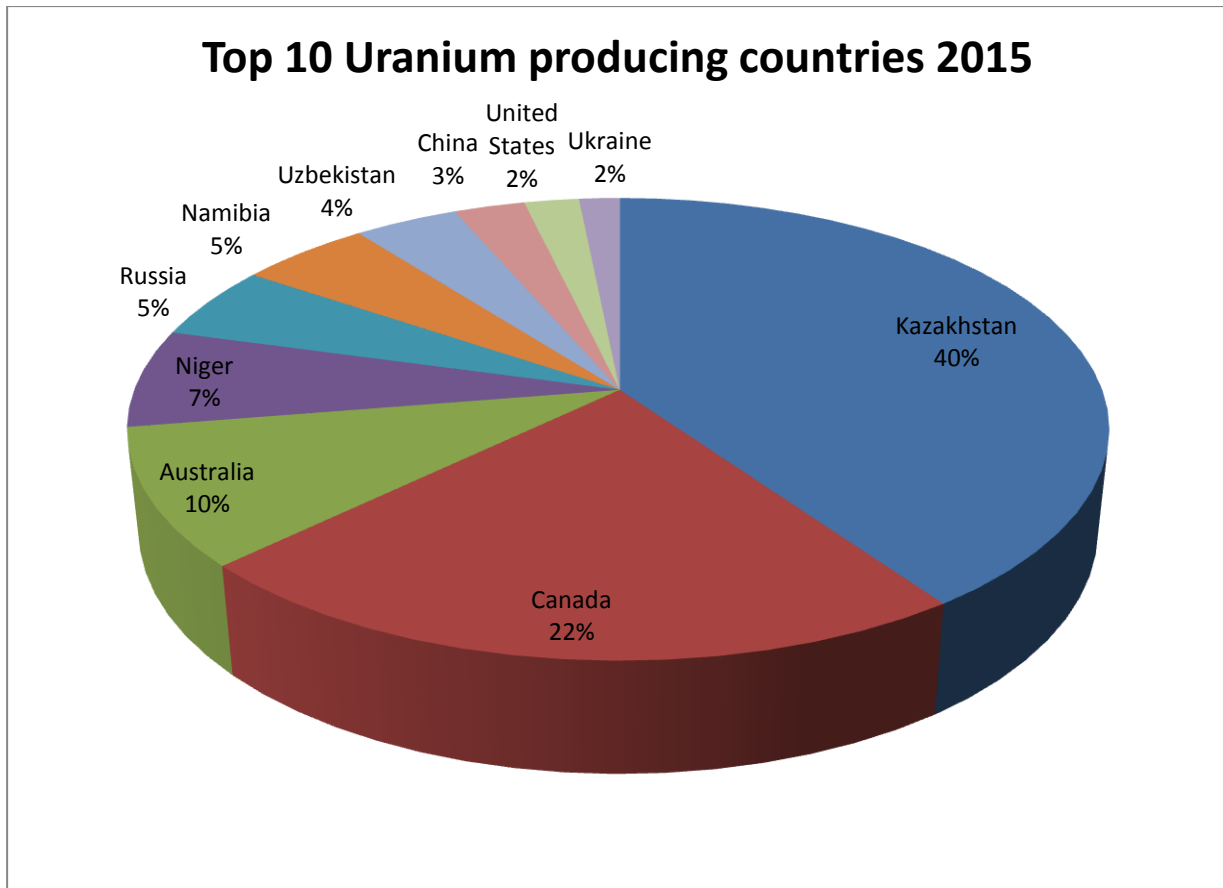


Figure 2: World uranium production in terms of percentage share (4)

Selected key points from Status of the front end of the NFC in Africa:

- i) The African continent (taken together) has the world’s second largest resources of uranium, after Australia. See Figure 1.
- ii) Uranium exploitation in Africa currently ranges from countries with economically exploitable resources that are still at the exploration phase, to countries like Niger, Namibia and South Africa that are major producers.
- iii) Artisanal mining is reportedly taking place in the DRC according to World Bank and the government of DRC (5) and possibly in other African countries. Artisanal mining by definition is uncontrolled by the government, and the products can therefore be exported without proper controls. Development and enactment of legislation and control measures, as well as the implementation of nuclear security measures could mitigate this problem.

2.2 Current Safeguards Model

The current safeguards model, NPT safeguards, is based on three pillars: i) The non-proliferation treaty (NPT); ii) safeguards agreements and additional protocols; and iii) the nuclear regulatory frameworks of States. The 2nd pillar, safeguards agreements and additional protocols originate from Article 3.1 of the NPT; and the 3rd pillar, State nuclear regulatory frameworks originates from paragraph 7 of the model safeguards agreement [*Model safeguards agreement (INFCIRC/153) para. 7: The Agreement should provide that the State shall establish and maintain a system of accounting for and control of all nuclear material subject to safeguards under the Agreement*].

2.2.1 Non-Proliferation Treaty (6)

The full name of the NPT is the Treaty on the Non-Proliferation of Nuclear Weapons. The Treaty was opened for signature in 1968, and entered into force in 1970. In 1995, the Treaty was extended indefinitely.

The NPT is the fundamental legal instrument through which IAEA was established and therefore nuclear materials are controlled around the world, including on the African continent.

Pursuant to Article III.1, each non-nuclear-weapon State party to the NPT undertakes to accept IAEA safeguards on all source or special fissionable material in all peaceful nuclear activities within the territory of such State, under its jurisdiction, or carried out under its control anywhere.

Pursuant to Article III.2, each State party to the NPT undertakes not to provide source or special fissionable material, or equipment or material especially designed or prepared for the processing, use or production of special fissionable material, to any non-nuclear-weapon State for peaceful purposes, unless the source or special fissionable material is subject to the safeguards required by Article III.1.

Article III.4 requires each non-nuclear-weapon State party to the NPT to conclude a safeguards agreement with the IAEA, either individually or together with other States, within 18 months of the date on which the State deposits its instruments of ratification of or accession to the Treaty.

The Status of the NPT in African States with significant nuclear resources and or activities is provided in Table 2.

Selected key points from the review of the NPT

- i) The part of the NPT that is currently used to control nuclear materials is Article III.1 which requires each non non-nuclear-weapon State Party to conclude a safeguards agreement with the IAEA. The safeguards agreement therefore establishes a legal obligation for the verification and monitoring of nuclear materials in the State.
- ii) Article III.2 of the NPT requires States not to export uranium ore concentrate (UOC), unless the UOC will be subject to safeguards in the importing State. Unlike NPT Article 3.1 which has an established safeguards regime to verify its provisions, there is no obligatory multilateral system for verifying the export control provisions. The verification of export control is not part of IAEA safeguards. This provision for export control is also part of the Pelindaba treaty, and the good news is that AFCONE, the authority to be responsible for ensuring compliance with the Pelindaba treaty is in the process of being setup.
- iii) One of the current weaknesses in the implementation of IAEA safeguards in Africa is due to the absence of the required competence in most of the national regulatory authorities. Article III.4 of the NPT allows a grouping of States to collectively conclude safeguards agreements with the IAEA. A collective safeguards agreement implies a multilateral regulatory authority. This would eliminate the lack of competence in individual States.

2.2.2 Safeguards Agreements and Additional Protocols

There are three main types of safeguards agreements; 'Comprehensive Safeguards Agreements' (CSA), 'Item Specific Safeguards Agreements' (ISA) and 'Voluntary Offer safeguards agreements' (VOA). (7)

CSA are concluded by non-nuclear weapon States (NNWS) that are party to the non-proliferation treaty (NPT). Under a CSA, safeguards are applied on all nuclear material in all peaceful nuclear activities in the State. Such a safeguards agreement is concluded on the basis of IAEA document INFCIRC/153 (Corrected) without modification of the text of the model.

ISA are concluded by States that are not party to the NPT. Under ISA, nuclear material, non-nuclear material (e.g., heavy water, zirconium tubes), facilities and/or equipment that are specified in the agreement are subject to safeguards. ISA are usually based on guidelines contained in INFCIRC/66/Rev.2. Item specific safeguards agreements are different from CSA in the sense that not all nuclear material in the State are covered by a single ISA agreement, and the scope of the agreements also includes non-nuclear materials - specified items and equipment that are not covered by CSA.

A VOA may be concluded between the IAEA and a nuclear-weapon State which, under the NPT, is not required to accept safeguards but which has voluntarily offered to do so. Under such an agreement, a State offers some or all of the nuclear material and/or facilities in its civilian nuclear fuel cycle, from which the IAEA may select for the application of safeguards. A voluntary offer safeguards agreement generally follows the model safeguards comprehensive safeguards agreement used for non-nuclear weapon states (INFCIRC/153 (Corrected)ⁱ).

On the African continent, all countries, except South Sudan are party to the NPT; and all African countries with significant uranium resources have concluded CSA agreements with the IAEA. See Annex 1 for summary of the safeguards agreements for the African States.

There are two options within the context of Comprehensive Safeguards Agreements:

- (i) CSA in which all the provisions of the model safeguards agreement (INFCIRC/153) apply.
- (ii) (ii) CSA in which some of the provisions of INFCIRC/153 are suspended. Such a CSA includes what is called a Small Quantities Protocol (SQP). SQP applies to countries with very small inventories of nuclear material (less than the limits specified in Paragraph 37 of INFCIRC/153). Apart from South Africa, Niger, Botswana and the DRC which have option (i) CSA, all other African States have CSA with SQP.

Under a CSA with SQP (which is the case in most of Africa), certain provisions are suspended, including the right of the IAEA to carry out inspections is suspended; and the obligation of the State to submit reports of its nuclear material inventories is also suspended. Furthermore, there is no legal instrument to change the SQP status of a State if for example it's holdings of nuclear material exceed the specified limits.

The suspension of provisions is a weakness that was recognized by the IAEA. In 2005, the IAEA revised the policy on SQPs and since then requires all States with SQP (on a voluntary basis) to adopt a modified SQP. Post 2005, the modified SQP will be the only option available for new safeguards agreements with States qualifying for SQP. The modified SQP requires States to report nuclear material inventories to the IAEA (no matter how small), and establishes the right of the IAEA to carry out on-site inspections in SQP States.

For States with Comprehensive Safeguards Agreements (CSA), paragraph 33 of their safeguards agreement excludes detailed nuclear material accounting for material in mining and milling (ore processing). This means that under CSA, States do not have to declare the quantity of uranium in the ore or in the ore concentrate. Figure 3 shows the part of the nuclear fuel cycle (in yellow) subject to detailed nuclear material accountancy and the part of the NFC not subject to detailed nuclear material accounting, under comprehensive safeguards agreements.

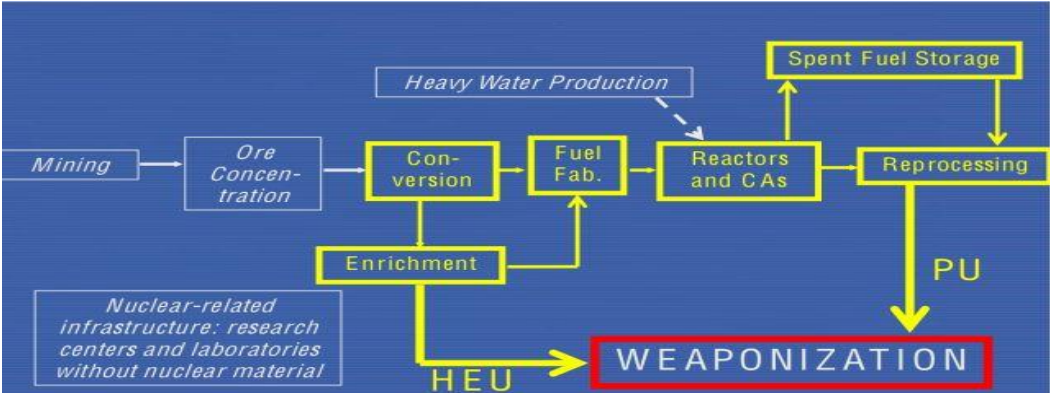


Figure 3: NFC stages subject to detailed nuclear material accountancy (8).

Under CSA paragraph 34a, only exports and imports of UOC for nuclear fuel cycle related purposes, and involving Non-Nuclear Weapon States (NNWS) are reported to the IAEA.

Comprehensive safeguards agreements have provision only for verifying the correctness of the State’s declaration, but not the completeness. In order to address this weakness, and to enable the completeness of the State’s declaration to be verified, the IAEA introduced the Additional protocol (AP) in 1997. Additional Protocols are based on IAEA document INFCIRC/540. Unlike the CSA or item specific agreements that are obligatory, the Additional Protocol is voluntary. Measures under the AP also enable the IAEA to verify the absence of undeclared nuclear materials and activities in a State.

Under the Additional Protocol Article 2, the State is required to declare an expanded range of information on nuclear fuel cycle activities. Expanded information includes, inter alia, more information on the front end of the NFC (mining and milling) beyond what is required in the safeguards agreement. More information is also provided on imports and exports of nuclear materials, and nuclear related future plans of the State. Figure 4 is a schematic of the scopes of the Additional Protocol and the safeguards agreement.

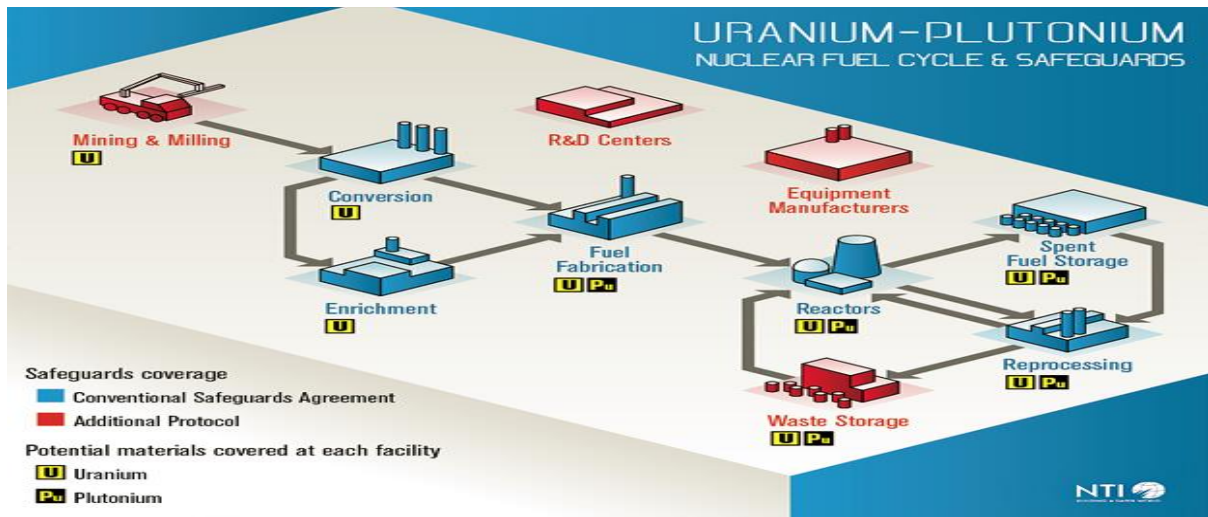


Figure 4: Scopes of safeguards agreement and additional protocol. (9)

COUNTRY	TYPE OF SAFEGUARS AGREEMENT	ADDITIONAL PROTOCOL	COMMENTS
Botswana	Comprehensive Safeguards Agreement (CSA) INFCIRC/694	INFCIRC/694/Add 1	
Central African Republic	CSA with Small Quantities Protocol (SQP) INFCIRC/777	INFCIRC/777/Add 1	SQP is modified: INFCIRC/777/Mod1
DRC	Comprehensive Safeguards Agreement (CSA) INFCIRC/183	INFCIRC/183/Add 1	DRC
Malawi It all starts here™	CSA with Small	INFCIRC/409/Add 1	SQP is modified:

COUNTRY	TYPE OF SAFEGUARS AGREEMENT	ADDITIONAL PROTOCOL	COMMENTS
	Quantities Protocol (SQP) INFCIRC/409		INFCIRC/409/Mod1
Namibia	CSA with Small Quantities Protocol (SQP) INFCIRC/551	INFCIRC/551/Add 1	SQP not modified
Niger	Comprehensive Safeguards Agreement (CSA) INFCIRC/664.	INFCIRC/664 Add.1	
South Africa	Comprehensive Safeguards Agreement (CSA): INFCIRC/394	INFCIRC/394/Add 1	
Tanzania	CSA with Small Quantities Protocol (SQP) INFCIRC/643	INFCIRC/643/Add 1	SQP is modified: INFCIRC/643/Mod1
Zambia	CSA with Small Quantities Protocol (SQP) INFCIRC/456	Signed, but not yet ratified.	SQP not modified. No Additional Protocol in force.

Table 1: Status of safeguards agreements and Additional protocols in African countries with the front end of the NFC. (10)

Selected key points from Safeguards Agreements and Additional protocols

- i) Not all African countries with Small Quantities Protocol (SQP), including some with significant uranium resources, have modified or rescinded their SQP. Without the modified SQP, there is no mechanism for reporting or for controlling and monitoring nuclear materials on the territory of a State.

- ii) Not all African countries with safeguards agreements, including one (Zambia) with significant uranium resources have an Additional protocol in force with the IAEA. Without the Additional Protocol, the State does not make declarations about the following NFC front end activities: location and annual production of uranium mines and uranium concentration plants.
- iii) For States with Comprehensive Safeguards Agreements (CSA), paragraph 33 of their safeguards agreement excludes detailed nuclear material accounting for material in mining and milling (ore processing). UOC is the feed material for conversion 1 facilities. Since UOC is not subject to detailed nuclear material accountancy, the amount of material that can potentially be transferred to conversion facilities is not known to the IAEA. Therefore, it is not possible for the IAEA to have full confidence that undeclared nuclear material is not introduced into conversion facilities for clandestine processing. States may voluntarily choose to apply detailed nuclear material accountancy to uranium ore concentrate.
- iv) Under CSA, only exports and imports of UOC for nuclear fuel cycle related purposes, and involving Non-Nuclear Weapon States (NNWS) are reported to the IAEA.

Under VOA, Nuclear Weapon States (NWS) voluntarily offer only a few selected nuclear facilities are offered for safeguards. No NWS has ever offered a Conversion facility to safeguards, and it is unlikely that such facilities will be offered in the future. Hence, the IAEA has no way, under the VOA, to reconcile shipments of UOC to a NWS. With regards exports to NNWS, only those exports of UOC for nuclear purposes are reported. However, imagine that two NNWS are collaborating on proscribed activities, the IAEA will have no way of knowing if the two States collaborate on false reporting because the exports/imports or inventories of UOC are not verified by the IAEA. Proscribed activities are any activities that may facilitate the production of a nuclear weapon or other nuclear explosive device through the diversion of nuclear material subject to safeguards or the misuse of a safeguarded facility. [Paragraph 2, CSA – INFCIRC/153; NPT Article III]

2.2.3 Nuclear Regulatory Framework – National Legislation & Administrative Control

2.2.3.1 FNRBA - Forum of Nuclear Regulatory Bodies in Africa (11)

The Forum of Nuclear Regulatory Bodies in Africa, the FNRBA, was founded in March 2009 to:

- Provide a platform for fostering regional cooperation;*
- Provide for the exchange of expertise, information and experience;*
- Provide opportunity for mutual support and coordination of regional initiatives; and*
- Leverage the development and optimisation of resource utilization.*

The forum is open to all nuclear regulatory bodies in the region and it is voluntary.

Provided below, is a brief description of the status of nuclear regulatory bodies and the relevant national legislation in those African countries with significant uranium resources and/or nuclear activities.

2.2.3.2 NAMIBIA

The Atomic Energy and Radiation Protection Act was enacted in May 2005 to: 1) Provide for the adequate protection of the environment and future generations against the harmful effects of radiation; 2) to establish an Atomic Energy Board; and 3) to establish a National Radiation Protection Authority.

The Nuclear Regulatory Authority in Namibia is the Atomic Energy and Radiation Protection Authority (AERPA), which is under the Ministry of Health and Social Services.

2.2.3.3 NIGER

All nuclear regulatory, control and promotion matters are under the High Authority for Atomic Energy (HANEA). HANEAE is the Safeguards Regulatory Authority (SRA), as well as the national regulatory authority. HANEAE reports directly to the office of the President of Niger, and the current Director of HANEAE is the official focal point to the IAEA.

In its national report to the 1540 Committee, in 2008, Niger stated that under Article 132 of its Constitution, international law is superior to national legislation in Niger. Niger codified its first mining law on Ordinance No 93-16 on 2 March 1993, which has undergone several updates, the most recent in 2006.

2.2.3.4 MALAWI

In 2011, the Malawian National Assembly passed the Atomic Energy Bill, putting in place a regulatory framework for nuclear related activities, including uranium mining and milling activities. Under this Bill the Atomic Energy Regulatory Authority (AERA), which is not yet operational, was established. In addition, the Bill also established the Atomic Energy Regulatory Board (AERB), appointed by the President of Malawi. However, since the Bill was passed, no operational budget has been allocated for the establishment of the AERA and board members have not yet been appointed to the AERB. So, in summary, Malawi does not have an operational independent nuclear regulatory body.

2.2.3.5 DEMOCRATIC REPUBLIC OF CONGO (DRC)

The nuclear regulatory authority in the DRC is the Commissariat General al'Energie Atomique (CGEA) which was established on 5 May 1978.

There are no specific legislation governing safeguards or the physical protection of nuclear materials and facilities; however the CGEA carries out all safeguards functions, providing reports and declarations to the IAEA under their safeguards agreement and additional protocol.

The Act on protection against the dangers of ionizing radiation and on the physical protection of nuclear materials and installations (No.017/2002) was adopted and entered into force on 16 October 2002. Any activity involving exposure to ionizing radiation requires a licence and is regulated in accordance with the basic radiation protection and safety standards defined by the IAEA.

2.2.3.6 UNITED REPUBLIC OF TANZANIA

Tanzania has legislation governing nuclear activities. The Tanzania Atomic Energy Commission (TAEC) was established in 2004 and is responsible for performing Safeguards Regulatory functions. TAEC is responsible for submitting declarations to the IAEA under the comprehensive safeguards agreement and the additional protocol thereto. TAEC is also responsible for all matters relating to the safe and peaceful use of atomic energy and nuclear technology, including radio-active materials and radiation devices.

2.2.3.7 CENTRAL AFRICAN REPUBLIC

Law No. 06.031 on radioactive ores (Loi générale sur le minerais radioactifs de la République Centrafricaine) was enacted on 27 September 2006. The law provides, among other things, for the establishment of the National Agency for Radiation Protection (L'Agence Nationale de Radioprotection) (ANR) as a regulatory body. The Statute of ANR was approved by Decree No. 08.167 of 22 April 2008. In 2009, the Council of Ministers approved Decree No. 9 establishing regulations concerning radiation protection, safety and security of radioactive sources. The ANR is responsible for submitting declarations to the IAEA under the comprehensive safeguards agreement and the additional protocol thereto.

2.2.3.8 SOUTH AFRICA

The nuclear regulatory authority of South Africa for safeguards purposes is the Ministry of Energy as defined in Nuclear Energy Act 46 of 1999, section 33(1). However, the implementation of South Africa's safeguards obligations has been delegated to the South African Nuclear Energy Cooperation (NECSA). NECSA is responsible for submitting declarations to the IAEA under the comprehensive safeguards agreement and the additional protocol thereto.

2.2.3.9 BOTSWANA

The Ministry of communications, science and technology is the responsible authority for safeguards related matters. However, a department of Radiation protection was created as defined by their Radiation Protection Act, 2006(Act no.22/2006) to be the national liaison to the IAEA for safeguards implementation in Botswana.

2.2.3.10 ZAMBIA

Zambia has no established safeguards regulatory authority and State System for Accounting and Control (SSAC) of nuclear material. However, Zambia's relationship with the IAEA for matters related to safeguards obligations under the NPT and safeguards agreement are being managed by the Zambia Radiation Protection Authority.

Selected key points from Nuclear Regulatory Authorities

- i) Some of the States with significant uranium resources do not have a functioning nuclear regulatory authority.
- ii) Some of the States with significant uranium resources have a nuclear regulatory authority, but not one that is independent from the entities being regulated.
- iii) Some of the States with significant uranium resources do not have a robust legislative framework.

2.3 Nuclear Security

Nuclear security deals with 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 (12)

Nuclear security issues can be addressed in a number of ways, including focusing on who is responsible, such as the State itself, International and multilateral Organizations such as the IAEA, and direct cooperation between countries; or focusing on the specific nuclear security concerns such as Artisanal mining and Illicit trade networks such as the AQ Khan network.

2.3.1.1 IAEA involvement

Nuclear security is one of the areas in which the IAEA provides a forum for cooperation with and between IAEA member States. Unlike safeguards, nuclear security cooperation with member States is voluntary – not obligatory.

The nuclear security contact point at the IAEA is the Department of Nuclear Safety and Security. The safeguards activities carried out by the IAEA Department of Safeguards overlaps with nuclear security - such as nuclear material accountancy, satellite imagery, radar imagery and the monitoring of trade in nuclear energy.

IAEA technical assistance in the area of nuclear security is provided through Integrated Nuclear Security Support Plan (INSSP) developed jointly with the IAEA. The INSSP is aimed at identifying activities necessary to build an effective and sustainable nuclear security regime in the country.

INSSP provides a customized framework for coordinating and implementing nuclear security activities conducted by the country, the IAEA, and potential partners, in a systematic manner. The INSSP covers all aspects related to nuclear security: legislative and regulatory framework, prevention, detection, response, and sustainability. An INSSP implementation plan is also established.

Other nuclear security relevant outreach support & cooperation activities carried out by the Department of Nuclear Safety and Security include:

(a). Nuclear Security Advisory Services

Nuclear security missions, evaluations and technical visits are the IAEA's main tool for helping States to assess their nuclear security needs, and provide a basis for formulating plans.

The needs identified by such missions can be subsequently addressed by the State alone, in conjunction with Agency support, or with the assistance of a bilateral partner. The IAEA often plays a role in coordination of these activities, even when it is not directly involved.

The Nuclear Security Advisory Services provided by the IAEA include:

- The International Nuclear Security Advisory Service (INSServ) mission serves as a flexible mechanism to help identify a State's broad nuclear security requirements and the measures needed to meet them. *The INSServ Report, once agreed by the host State, serves as the basis for nuclear security cooperation between the IAEA and the State and, with the consent of the State, as a vehicle for the coordination of bilateral nuclear security assistance* (13).

International Physical Protection Advisory Service

- The International Physical Protection Advisory Service (IPPAS) mission (14) serves as the IAEA's chief tool for evaluating existing physical protection arrangements in Member States. IPPAS missions carry out detailed reviews of the legal and regulatory basis for the physical protection of nuclear activities in the requesting State and of compliance with obligations contained in the amendment to the Convention on Physical Protection of Nuclear Material (CPPNM). They also compare the established national practices with the guidance provided in IAEA documents as well as with international best practices. The findings of IPPAS missions are formulated into confidential mission reports for further action on a multilateral, bilateral or unilateral basis. Specific IPPAS follow-up assistance such as training, technical support and more targeted assessments constitute an essential feature of this advisory service.

Regulatory Services:

- The IAEA Integrated Regulatory Review Service (IRRS) (15) is designed to strengthen and enhance the effectiveness of the national regulatory infrastructure of States for nuclear, radiation, radioactive waste and transport safety and security of radioactive sources whilst recognizing the ultimate responsibility of each State to ensure safety in the above areas. This expressed purpose of the IRRS is to be accomplished through consideration of both regulatory technical and policy issues, with comparisons against IAEA safety standards and where appropriate, good practices elsewhere.

(b).The Illicit Trafficking Database (ITDB) (1)

IAEA member States are invited to participate in the IAEA's Illicit Trafficking Database (ITDB). Established in 1995, the ITDB is the IAEA's information system on incidents of illicit trafficking and other unauthorized activities and events involving nuclear and other radioactive material outside of regulatory control. The ITDB is a unique asset helping participating States and selected international organizations to combat illicit nuclear trafficking and strengthen nuclear security. The ITDB provides a reporting mechanism for incidents involving the trafficking of nuclear and radioactive materials.

All 8 African States considered in this project participate in the IAEA's Illicit Trafficking Database (ITDB) for nuclear and radioactive materials (See table 2 below). However, as of 31 December 2015, only 31 countries on the African continent participate in the ITDB.

The purposes of ITDB are:

- To facilitate the timely exchange of authoritative information among States on incidents of illicit trafficking and other related unauthorized activities involving nuclear and other radioactive materials;
- To collect, maintain and analyse information on such incidents with a view to identifying common threats, trends and patterns;
 - use this information for internal planning and prioritization
 - provide this information to Member States
- To provide a reliable source of basic information on such incidents to the media, when appropriate.

The ITDB covers incidents involving:

- ✓ Unauthorized acquisition (theft), provision, possession, use, transfer or disposal of nuclear and other radioactive materials;
- ✓ Intentional or unintentional;
- ✓ With or without crossing international borders;
- ✓ Unsuccessful or thwarted acts of the above type;
- ✓ Loss of materials and;
- ✓ Discovery of uncontrolled materials.

Summary of African Incidents

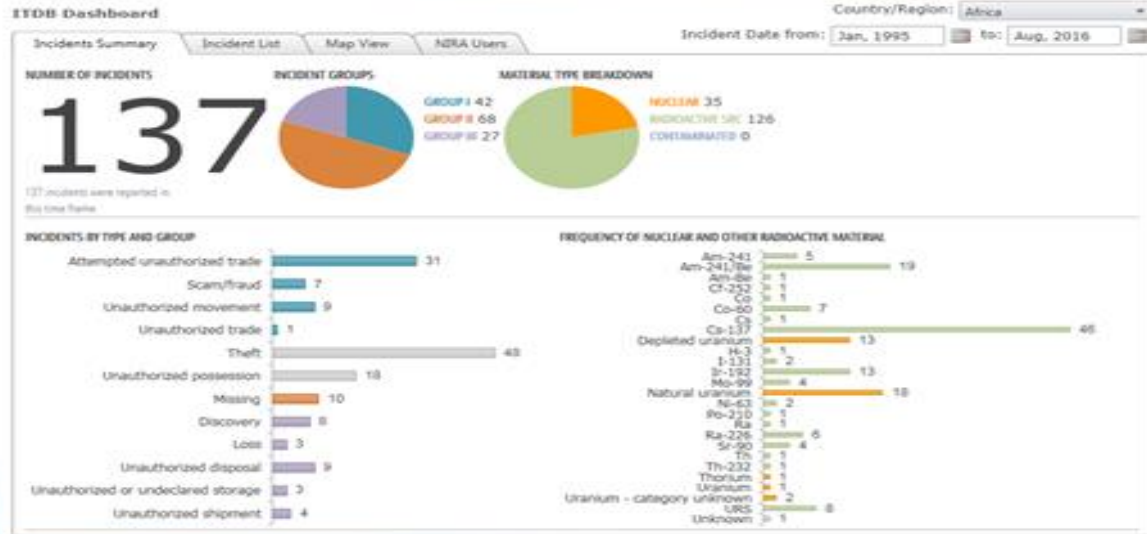


Figure 5: African Illicit Trafficking incidents from 1995 – 2016. (16)

Selected key points from review of nuclear security

- i) Artisanal mining is common in countries where there isn't sufficient government oversight of the mining industry, and in particular DRC (5). This situation can lead to clandestine mining and export of uranium ores and/or uranium containing ores.
- ii) Nuclear security issues can be addressed via cooperation between the State and the IAEA. The IAEA provides Nuclear Security Advisory Services which include enhancing national regulatory infrastructure, physical protection, and having the State participate in the IAEA's Illicit Trafficking database.

- iii) Nuclear security issues can be addressed via direct cooperation with 3rd parties. The United States government, for example, has programmes, such as the Mega ports initiative, that provide nuclear security assistance to African States. Other programmes, such as the US State Department's Nuclear Smuggling Outreach Initiative and the DRC have developed and approved a joint action plan, signed 21 December 2010, as well as a list of assistance projects to help the DRC implement that plan. The implementation of similar joint action plans in other countries has produced tangible improvements in the physical protection of nuclear and highly radioactive materials, in nuclear regulatory systems and export controls, in security at airports, seaports, and land border crossings, in laws to combat nuclear smuggling, in national plans and capabilities to respond to smuggling incidents; and in other key capabilities. (17)
- iv) In the period from 1995 – 2006, 137 incidents involving African countries were reported in the IAEA's Illicit Trafficking database (ITDB), 35 are nuclear related involving Thorium, Natural uranium and depleted uranium, and 135 involving radioactive sources. Strengthening the control of nuclear and radioactive materials across national borders would mitigate problem of illicit trafficking. See figure 5 for summary of African incidents extracted from IAEA Illicit trafficking database.
- v) Not all African countries are currently participating in the IAEA's Illicit Trafficking Database.

2.4 Other non-proliferation related international agreements and obligations.

Apart from the Non-Proliferation Treaty and Safeguards Agreements and Additional Protocols with the IAEA, African States are also parties to other non-proliferation related multilateral agreements – listed below in Table 2 below. From amongst these, the CTBT, the CWC, and the Pelindaba Treaty are reviewed in detail in Sections 2.5 and 2.6.

	Central African Republic	DRC	Malawi	Namibia	Tanzania	Niger	South Africa	Botswana	Zambia
Treaty on the Non-Proliferation of Nuclear Weapons (NPT)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
African Nuclear Weapons Free Zone Treaties (The Treaty of Pelindaba)	No. Signed, but not ratified	No. Signed but not ratified	Yes	Yes	Yes	Yes. Ratified in 2016	Yes	Yes	Yes
Convention on the Physical Protection of Nuclear Material (CPPNM)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

	Central African Republic	DRC	Malawi	Namibia	Tanzania	Niger	South Africa	Botswana	Zambia
Amended Convention on the Physical Protection of Nuclear Material (CPPNME)	No	No	No	No	No	No	Yes	No	No
Comprehensive Test Ban Treaty (CTBT)	No	No	No	No	No	No	Yes	Yes	Yes
Partial Test Ban Treaty	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes
International Convention for the Suppression of Acts of Nuclear Terrorism	No	Yes	No	No	No	Yes	Yes	No	No
IAEA Illicit Trafficking Database (ITDB) ⁱⁱ	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 2: Non-Proliferation treaty and other related international agreements and obligations. (10)

2.5 Other verification frameworks

The control of the front end of the nuclear fuel cycle is mainly carried out by what has been referred to in this research project as the standard safeguards model – which is comprehensive safeguards under the NPT – Model safeguards agreement (INFCIRC/153) and the Additional protocol (INFCIRC/540).

In this Section, we will review other verification models (outside the framework of the standard safeguards model) in order to identify best practices that can be adapted and/or adopted to strengthen the standard safeguards model.

The other verification models selected for consideration in this Section are: EURATOM safeguards, The Joint Comprehensive Plan of Actionⁱⁱⁱ (JCPOA), The Comprehensive Test Ban Treaty Organization (CTBTO), and the Organization for the Prohibition of Chemical Weapons (OPCW).

2.5.1 EURATOM Safeguards

The "Treaty establishing the European Atomic Energy Community", (Euratom Treaty) was signed in Rome in 1957 (18), and includes a chapter on nuclear safeguards. This chapter specifies that in the territories of Member States, ores, source materials and special fissile materials are not diverted from their intended uses as declared by the users. EURATOM is also responsible for ensuring compliance with provisions relating to supply and any particular safeguarding obligations assumed by the Community under an agreement concluded with a third State or an international organization.

EURATOM is unique in the field of safeguards. This is due to the fact that it is a regional safeguards authority invested with supranational rights, fulfilling the tasks normally assigned to a national safeguards authority.

Such a supranational system will only work if it has the support of all its member States. The EURATOM system has been an integrating factor, contributing to the development of an interconnected nuclear industry in Europe. Its personnel are drawn from all the Member States.

The Euratom Treaty is administered by a Commission which is independent of the member States.

In the application of safeguards, the Commission deals directly with the facilities under safeguards, and not with the governments of the member States. The EURATOM safeguards system is therefore a supranational system, with certain rights of sovereignty having been handed over by the States to the European Commission. (19).

In addition to EURATOM safeguards, European Union countries are subject to IAEA safeguards. Article III of the Non-Proliferation Treaty requires the application of IAEA safeguards to all non-nuclear weapon States party to that Treaty² and furthermore foresees that these requirements can be met by the States either individually or together with other States (NPT Article III.4) in accordance with the Statute of the International Atomic Energy Agency. This is the case in the European Community, where all non-nuclear weapon States in the EU are under one safeguards agreement with the IAEA INFCIRC/193. (20).

Collaboration with the IAEA

INFCIRC/193 includes a protocol that specifies the details of how EURATOM will cooperate with the IAEA in the application of safeguards; in order to ensure that the cooperation will facilitate the achievement of safeguards objectives by each organization, and that there is no unnecessary duplication of effort.

Selected best practices and outcomes from EURATOM safeguards:

- i) Article III.4 of the Non-Proliferation Treaty requires all non-nuclear weapon States party to that Treaty to conclude safeguards agreements with the IAEA either individually or together with other States in accordance with the Statute of the International Atomic Energy Agency. This is the case in the European Community, where all non-nuclear weapon States in the EU are under one safeguards agreement INFCIRC/193. It would make sense if African countries, in accordance with Art.III.4 of the NPT, collectively conclude a safeguards agreement with the IAEA, like INFCIRC/193 for EURATOM States. This would simplify the administrative aspects of verification and monitoring, and it would enhance cooperation and exchanges between countries, especially in the field of nuclear energy, and possibly in the joint development of nuclear power.

- ii) It would be beneficial for African countries to copy EURATOM model because one of the main problems faced by the IAEA implementing safeguards in Africa is that most of the national regulatory authorities are not sufficiently competent to perform at the minimum level required to meet their multilateral safeguards obligations. AFCONE working as a regional regulatory authority, invested with the appropriate supranational authority, would help to bridge this gap. Furthermore, this would make sense considering that eleven³ (21) African countries are looking at developing nuclear power, not only individually, but also as joint ventures. A regional regulatory authority also responsible for nuclear material accountancy at jointly owned power plants (and other nuclear fuel cycle facilities) would not only ensure that the system works but would also benefit conformity to nuclear security norms.
- iii) Under EURATOM safeguards, uranium ore concentrate are subject to detailed nuclear material accountancy.

2.5.2 Joint Comprehensive Plan of Action (JCPOA). (22)

The Joint Comprehensive Plan of Action (JCPOA) on ensuring the exclusively peaceful nature of Iran's nuclear activities that was signed between Iran and the P5+1 Countries (United States of America, Russian federation, China, United Kingdom, France and Germany) on 15 July 2015. Implementation of the JCPOA started on 01 January 2016. The JCPOA has an administrative body called a Joint Commission with responsibility for overseeing the implementation of the JCPOA.

The NPT and the comprehensive safeguards agreement (including the Additional protocol) arising from it, also have as their objective, the exclusive peaceful nature of the nuclear programmes of NNWS party to the NPT. This begs the question why the JCPOA is needed as Iran already has a comprehensive safeguards agreement.

Agreements such as the JCPOA are therefore testimony that in certain circumstances, comprehensive safeguards agreements have weaknesses that are important from a non-proliferation point of view.

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³Algeria, Egypt, Ghana, Kenya, Morocco, Namibia, Nigeria, Tunisia, Zambia and Uganda

Under the JCPOA, *Iran will permit the IAEA to monitor, through agreed measures that will include containment and surveillance measures, for 25 years, that all uranium ore concentrate (UOC) produced in Iran or obtained from any other source, is transferred to the uranium conversion facility (UCF) in Esfahan or to any other future uranium conversion facility which Iran might decide to build in Iran within this period.* This provision goes beyond the requirements of NPT safeguards that do not require material accountancy on UOC; thus making UOC a potential loophole for the clandestine acquisition of nuclear material under NPT safeguards.

Under the JCPOA, if the IAEA raises a question regarding alleged undeclared nuclear material or undeclared nuclear activities, Iran must respond and the two sides must reach a satisfactory conclusion within 14 days of the IAEA's original request for access. If not, Iran, in consultation with the members of the Joint Commission, would resolve the IAEA's concerns through necessary means agreed between Iran and the IAEA. In the absence of an agreement, the members of the Joint Commission, by consensus or by a vote of 5 or more of its 8 members, would advise on the necessary means to resolve the IAEA's concerns. The process of consultation with, and any action by, the members of the Joint Commission would not exceed 7 days, and Iran would implement the necessary means within 3 additional days.

In the JCPOA, resolution of disputes (or questions) does not have an unspecified timeline as in the AP. A timeline is always specified during which the issue must be resolved or closed - paragraph 36 of the JCPOA

There are two types of resolution process foreseen under the JCPOA.

1) Dispute between JCPOA parties not involving the Agency: If Iran believed that any or all of the E3/EU+3 (China, France, Germany, the Russian federation, the United Kingdom and the United States, with the High Representation of the European Union for foreign affairs and security policy) were not meeting their commitments under this JCPOA, Iran could refer the issue to the Joint Commission for resolution; similarly, if any of the E3/EU+3 believed that Iran was not meeting its commitments under this JCPOA, any of the E3/EU+3 could do the same 30 days arbitration process.

2) Dispute between the Agency and Iran: If the IAEA has concerns regarding undeclared nuclear materials or activities, or activities inconsistent with the JCPOA, at locations that have not been declared under the comprehensive safeguards agreement or Additional Protocol, the IAEA will provide Iran the basis for such concerns and request clarification in accordance with 24 days arbitration period (Annex 1 of JCPOA, paragraph 78).

Selected best practices and outcomes from the JCPOA:

- i) The JCPOA has an administrative body called a Joint Commission with responsibility for overseeing the implementation of the JCPOA. The Treaty of Pelindaba's AFCONE (African Commission of Nuclear Energy) is nearly similar to JCPOA's Joint Commission. The Joint Commission of JCPOA does not have a Secretariat to implement the provisions of the JCPOA whereas AFCONE has a secretariat that is not fully operational. The Joint Commission of the JCPOA uses the Secretariat of the IAEA to implement the nuclear provisions of the JCPOA. An important difference between AFCONE and the Joint Commission of the JCPOA is that the Joint Commission uses the Secretariat of the IAEA for routine implementation of the JCPOA, while AFCONE only foresees to use the secretariat of the IAEA in cases of litigation.

Under the JCPOA, detailed nuclear material accountancy extends to uranium ore concentrate. This provision goes beyond the requirements of NPT safeguards that do not require detailed material accountancy on UOC; thus making UOC a potential loophole for the clandestine acquisition of nuclear material under NPT safeguards. While the Pelindaba Treaty only endorses NPT safeguards by the IAEA, African States could proactively include JCPOA style accountancy to UOC in their domestic safeguards.

- ii) Under the JCPOA, if the IAEA raises a question regarding alleged undeclared nuclear material or undeclared nuclear activities, all parties (including the Joint Commission if necessary) must reach a satisfactory conclusion within 24 days of the IAEA's original request for access. The type of arbitration process just described here is absent from the standard safeguards model. In the Additional Protocol (AP), the resolution of disputes (or questions) does not have a specified timeline as in the JCPOA. But Annex IV of the Pelindaba Treaty outlines a litigation process similar to that of the JCPOA. The only drawback of the litigation process under the Pelindaba Treaty is that the time frames may be too long for some safeguards scenarios. Such weaknesses may be resolved in revisions of the Treaty in accordance with *Article 19 of the Pelindaba Treaty (Amendments)*.

2.5.3 Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO)

The Comprehensive Nuclear-Test-Ban Treaty (CTBT) was signed in September 1996, and a Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) was established in Vienna, Austria. The role of the CTBTO include: Facilitating entry into force of the CTBT; development of the International Monitoring System and establishment of the International Data Centre. The CTBT is not yet in force, pending ratification by eight key States such as United States, China, Egypt, Iran, Israel, North Korea, India and Pakistan (23).

CTBTO's verification regime is designed to detect nuclear explosions conducted on earth, underground, underwater or in the atmosphere.

The CTBT monitoring system presently consists of 292 certified monitoring stations, 13 installed, and 7 under construction, 25 planned and 16 laboratories around the world. These 292 facilities monitor the earth for any sign of a nuclear explosion. Four verification technologies are currently used: Seismic, hydro-acoustic and infrasound technologies for monitoring underground explosions, under-water explosions and atmospheric explosions respectively; while Radionuclide technology is used to detect radioactive debris from atmospheric, underground or underwater nuclear explosions. Radionuclide laboratories associated with radionuclide stations are used to identify radioactive substances in the debris. Once certified as fully operational, local institutions are contracted by the CTBTO to operate the monitoring stations and laboratories (24).

The monitoring stations and laboratories are supported by a data processing centre located at the CTBTO headquarters in Vienna, Austria. Data transmission from the monitoring stations is presently accomplished through a network of six satellites. The satellites transfer the data to three hubs on the ground, for further routing to the data centre via terrestrial links.

Once the CTBT enters into force, any State party to the treaty will be able to request clarification directly from another State or through the Executive Council, if collected data is inconclusive about whether a nuclear explosion has taken place or not. . A State receiving a request for clarification has 48 hours to clarify the event in question.

In addition, once the CTBT is in force, member States will also have the right to request an on-site inspection in another member State regardless of the results of the clarification requested; in order to ascertain whether the State to be inspected carried out a nuclear explosion proscribed by the treaty.

The CTBT also includes confidence building provisions, whereby, member States are to voluntarily notify the CTBTO of any chemical explosions on their territories using 300 tonnes or more of TNT-equivalent blasting material. These notifications serve to contribute to the interpretation of verification data so that for example a large mining explosion is not confused for a nuclear explosion. They also serve for testing and fine tuning the monitoring stations

Selected best practices and outcomes from the CTBTO:

- i) Under the CTBT, States have the right to request an on-site inspection in another State, in order to clarify whether a violation of the CTBT took place. This is a right that is absent in the standard safeguards model (NPT safeguards), but available in the JCPOA. In the case of the Pelindaba Treaty, one State cannot directly force an inspection on another State; however a State can take a complaint to AFCONE and AFCONE can force the inspection if it is not satisfied by the resolution of the complaint provided by the State complained of.
- ii) The confidence building measures in the CTBT are similar to the Voluntary Reporting Scheme (VRS) that was introduced to NPT safeguards in the early 1990s, but has since been discarded in favour of the Additional Protocol. The idea of Voluntary Reporting could be beneficial, especially if the onus is on the State to report based on its own assessment.

2.5.4 Organization for the Prohibition of Chemical Weapons (OPCW). (25)

The OPCW - the Organization for the Prohibition of Chemical Weapons is an intergovernmental organization based in The Hague, the Netherlands; and responsible for administering the Chemical Weapons Convention (CWC). The CWC entered into force in 1997.

The Chemical Weapons Convention (CWC) prohibits the development, production, acquisition, retention, stockpiling, transfer and use of chemical weapons. It also prohibits all States Parties from engaging in military preparations to use chemical weapons, and from assisting or encouraging other States to engage in activities prohibited by the Convention. *The full name of the treaty is the Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction (26)*

The Verification regime of the CWC includes the on-site inspections of the chemical industry.

Furthermore, all States parties are required to declare information on chemical weapons; facilities storing and handling chemical weapons, as well as facilities that were used in the past for the development of chemical weapons.

Article IX grants CWC states-parties the right to request challenge inspections on the territory of another member state *“for the sole purpose of clarifying and resolving any questions concerning possible non-compliance”* (27)

Under the CWC, Schedule 1 chemicals may only be transferred to other States parties. Additionally, all transfers are subject to advance notification, and re-export is not permitted. Transfer to any State not party to the CWC is forbidden under any circumstances

Selected best practices and outcomes from the OPCW:

- i) Unlike the Chemical Weapons Convention, the Pelindaba treaty does not have clauses on general confidentiality of information, except on ad hoc confidentiality requirements, if required by inspections arising from the arbitration process (Annex IV.4.a). However, the Pelindaba Treaty requires all States party, to conclude comprehensive safeguards agreements with the IAEA, and IAEA safeguards have clauses on general confidentiality of information. Hence, it may be argued that general confidentiality of information is in the spirit of the Pelindaba treaty.
- ii) Under the CWC, States are required to declare information on past activities related to the development of chemical weapons. This requirement is not required under NPT safeguards, but in the practice of NPT safeguards information on past nuclear activities is often requested to resolve questions.
- iii) Article IX grants CWC states-parties the right to request a challenge inspection of any site, declared or undeclared, on the territory of another member state *“for the sole purpose of clarifying and resolving any questions concerning possible non-compliance.”* The option of challenge inspections is not available in NPT safeguards implemented by the IAEA in Pelindaba Treaty countries, but the Pelindaba Treaty itself makes provision for challenge inspections (Annex IV). The idea of challenge inspections adds another level of ensuring compliance by empowering member States to be vigilant about what their neighbour is doing within the framework of the treaty. In some ways, this is analogous to the idea of ABACC where Brazil and Argentina have agreed to monitor each other.

- iv) Under the CWC, a notice period is provided prior to any shipment of Schedule 1 chemicals. This notice period allows verification of the material before the shipment. This is key feature that could be adopted for the verification and monitoring of uranium ore concentrate in the front end of the nuclear fuel cycle.
- v) Under the CWC, re-export of Schedule 1 chemicals is not permitted. This is a provision that if incorporated in NPT safeguards would eliminate scenarios involving middle “men”. Under the CWC, transfer of Schedule 1 chemicals to States that are not party to the CWC is forbidden under any circumstances. This provision is in the NPT without the caveat of “under any circumstances”. In the Pelindaba Treaty, this provision is fully present.

2.6 Nuclear Weapons Free-Zones

A nuclear-weapon-free zone (NWFZ) is a specified region in which countries commit themselves not to manufacture, acquire, test, or possess nuclear weapons (28) Five such zones exist today. The regions currently covered under NWFZ agreements include: Latin America (the 1967 Treaty of Tlatelolco), the South Pacific (the 1985 Treaty of Rarotonga), Southeast Asia (the 1995 Treaty of Bangkok), Africa (the 1996 Treaty of Pelindaba) and Central Asia (the 2006 Treaty of Semipalatinsk). Similar to nuclear-weapon-free zones, treaties such as - The Sea Bed Treaty (1971), the Outer Space Treaty (1967) and the Antarctic Treaty (1959) prohibit the deployment of nuclear weapons from the specific areas; and individual countries such as Mongolia and Austria have declared themselves as nuclear weapons free countries.

Article VII of the NPT affirms the right of countries to establish specified zones free of nuclear weapons. The UN General Assembly resolution 3471B (1975) reaffirmed that right in 1975 (29) and outlined the criteria for such zones. Within these nuclear-weapon-free zones, countries may use nuclear energy for peaceful purposes.

Each treaty establishing a nuclear-weapon-free zone includes a protocol for the five nuclear-weapon states recognized under the NPT-China, France, Russia, the United Kingdom, and the United States to sign and ratify. These protocols, which are legally binding, call upon the nuclear-weapon states to respect the status of the zones and not to use or threaten to use nuclear weapons against treaty states-parties.

Such declarations of non-use of nuclear weapons are referred to as negative security assurances. However, the five nuclear-armed countries have at times signed and ratified a NWFZ protocol and declared conditions reserving the right to use nuclear weapons in certain scenarios against parties to a nuclear-weapon-free zone.

For instance, the United States signed the protocol for the African nuclear-weapon-free zone in April 1996 with a declaration that it would reserve the right to respond with all options, implying possible use of nuclear weapons, to a chemical or biological weapons attack by a member of the zone. None of the nuclear-weapon states have signed the relevant protocol for the treaty creating a zone in Southeast Asia because of concerns that it conflicts with the right of their ships and aircraft to have freedom of movement in international waters and airspace. The other three zones do not explicitly rule out the transit of nuclear weapons by nuclear-weapon states through the zones, and the general practice of nuclear-weapon states is not to declare whether nuclear weapons are aboard their vessels.

2.6.1 Pelindaba Treaty^{iv}

The Pelindaba Treaty is the Nuclear Weapons Free Zone (NWFZ) treaty on the African continent. The treaty applies to the entire territories of all African States. Territory is understood to include all land holdings, internal waters, territorial seas, and archipelagic waters. A dispute exists over the inclusion of the Chagos Archipelago, which includes the U.S. military base at Diego Garcia in the Indian Ocean, as part of the proposed African nuclear-weapon-free zone. Neither the United States nor the United Kingdom recognizes Diego Garcia as being subject to the Pelindaba Treaty.

In July 1964, the then Organisation of African Unity (OAU) adopted the declaration on the denuclearization of Africa as per resolution AHG/Res. 2(I). (30). The final text of the Treaty of Pelindaba was completed at a meeting of experts in South Africa in 1995, and was approved by African Heads of State on 23 June 1995. The Treaty was signed in 1996 in Cairo.

According to Article 18.2 of the Treaty, twenty-eight ratifications are required for entry into force of the Treaty. This occurred in July 2009, and the Treaty of Pelindaba entered into force in July 2009^v.

The Pelindaba Treaty enables the African continent to meet its obligations under NPT Article VII (NWFZ) and Article II (Not to receive nuclear weapons); as well as reinforcing the disarmament commitment taken by NPT nuclear weapon States under Article VI (Disarmament).

Article 12.1 of the Pelindaba Treaty requires that: *“For the purpose of ensuring compliance with their undertakings under this Treaty, the parties agree to establish the African Commission on Nuclear Energy (hereinafter referred to as the Commission) as set out in annex III of the Treaty”*.

Under Articles 14, a conference of all parties to the *Treaty shall be convened by the African Union as soon as possible after the entry into force of the Treaty to, **inter alia**, elect members of the Commission, to consult on matters related to the role and functions of the Commission, and to determine its headquarters.*

On 4 November 2010, this conference took place and participants endorsed a decision taken in Cairo in 1996 to establish the headquarters of African Commission of Nuclear Energy (AFCON) in South Africa.

Article 9 and Annex II of the Pelindaba Treaty require African State *parties to conclude safeguards agreements with the International Atomic Energy Agency (IAEA) for the purpose of implementing the safeguards required under the NPT.*

Article 9(c) of the Pelindaba treaty requires all *States party to the treaty not to provide source or special fissionable material, or equipment or material especially designed or prepared for the processing, use or production of special fissionable material for peaceful purposes to any non-nuclear-weapon State unless subject to a comprehensive safeguards agreement concluded with IAEA.* This requirement goes beyond NPT Article III.2 because it not only requires IAEA safeguards on the exported material, but requires the importing State to first conclude a Comprehensive Safeguards Agreement with the IAEA.

Selected best practices and outcomes from the Pelindaba Treaty:

- i) In the review of NWFZ agreements, the Pelindaba treaty was found to be more of a general agreement on nuclear cooperation than the others. It is possible that the drafters of the Pelindaba treaty had as one of their principal motives, the promotion of cooperation in the nuclear field in Africa. What does this have to do with the front end of the nuclear fuel cycle? One of the weaknesses in implementation of the non-proliferation regime in Africa is that there isn't rigorous controls on the movement of uranium (and other minerals containing uranium) across borders. Enhanced cooperation between the States (under the auspices of AFCONE) would introduce transnational coordination in the control of the transport of mineral ores.
- ii) Article 9(c) of the Pelindaba Treaty prevents African States from exporting uranium to States such as Pakistan (31) which have not concluded comprehensive safeguards agreements with the IAEA. In order to enforce this provision, AFCONE should take steps to ensure that African States apply nuclear export policies and practices in line with the internationally established standards for the export of nuclear material

2.6.2 TLATELOLCO TREATY

The Tlatelolco Treaty is the Nuclear Weapons Free Zone (NWFZ) treaty in Latin America.

The Tlatelolco Treaty prohibits Latin American states from acquiring, possessing, developing, testing or using nuclear weapons, and prohibits other countries from storing and deploying nuclear weapons on their territories.

The treaty was signed in 14 February 1967 in Mexico and entered into force on 25 April 1969. On 23 October 2002, the Tlatelolco Treaty came into full force throughout the region when Cuba, the only state which had not ratified the treaty, deposited its instrument of ratification. Currently, all 33 states in the region of Latin America and the Caribbean have signed and ratified the treaty.

The Tlatelolco Treaty was the first NWFZ Treaty to be signed and predates the nuclear non-proliferation treaty (NPT) which entered into force in 1970. The Tlatelolco Treaty has served as a model for the four NWFZ Treaties that came afterwards.

Verification under the Tlatelolco Treaty is accomplished by concluding multilateral or bilateral agreements with the International Atomic Energy Agency (IAEA) for the application of its safeguards to nuclear activities of States parties to the treaty. In addition, the Agency for the Prohibition of Nuclear Weapons in Latin America and the Caribbean (OPANAL) is an inter-governmental agency created by the Treaty of Tlatelolco to ensure that the obligations of the treaty are met.

In addition, Brazil and Argentina have created an organization called ABACC-Brazilian-Agency for Accounting and Control of Nuclear materials. Although it is not included in the Tlatelolco Treaty, ABACC was created in the spirit of OPANAL, establishing a mechanism for neighbouring countries to watch each other. Under ABACC, they have established the Common System of Accounting and Control of Nuclear Materials (SCCC) in order to verify that nuclear materials used in all nuclear activities in both countries are not diverted to purposes prohibited by the agreement.

The objective of ABACC is to administer and implement the SCCC: to carry out inspections in each country by ABACC inspectors, to designate ABACC inspectors from both countries, to evaluate inspections, to engage the necessary services to ensure fulfilment of the SCCC objectives, to represent the parties before third parties in connection with the implementation of the SCCC, and to take legal action. The Quadripartite Agreement between the two governments, the ABACC, and the International Atomic Energy Agency (IAEA) gives the IAEA the responsibility of applying full safeguards in both countries.

As regards compliance, the General Conference, the supreme organ of the OPANAL agency, will take note of all cases in which any contracting party is not complying fully with its obligations under this treaty and shall draw the matter to the attention of the party concerned, making such recommendations as it deems appropriate. If such non-compliance constitutes a violation of this treaty which might endanger peace and security, the General Conference may report simultaneously to the United Nations Security Council and the General Assembly through the Secretary-General of the United Nations, and to the Council of the Organization of American States. The General Conference shall likewise report to the IAEA for such purposes as are relevant in accordance with its Statute.

Selected best practices and outcomes from the Tlatelolco Treaty:

- i) Like OPANAL, the treaty of Pelindaba does not have a secretariat to verify and/or carry out the provisions of the treaty. In the case of Latin America, two of the countries, Brazil and Argentina, took the initiative to create such a secretariat to carry out the safeguards provisions of the treaty. This is reminiscent of the NPT, where a number of States party to the treaty took the initiative to create the nuclear suppliers Group (NSG) in order to be able to implement the provisions of Article III.2 of the NPT.

2.7 Other strategic minerals

2.7.1 Diamond industry

Like Uranium, diamond is a strategic mineral that is subject to control measures. The strategic value of diamonds are mostly in their economic value as well as in concerns about diamonds being used to finance malicious acts and conflicts; while the strategic value of uranium is mostly in its application in nuclear weapons. However, the two minerals require similar control and monitoring mechanisms by their respective industries.

Diamonds are amongst the most highly regulated minerals in the world. In 2000, diamond producing States met in Kimberly, South Africa to develop control mechanisms for trading of rough diamonds. The outcome of the meeting was the establishment of the Kimberly Process certification Scheme (KPCS) which entered into force in 2003.

The KPCS requires its members to certify that shipments of rough diamonds are 'conflict-free' and to prevent conflict diamonds from entering legitimate trade. Additionally, the KPCS requires participating States to promulgate national legislation and to establish institutions for controlling imports and exports of rough diamond-section IV, a. (32)

Although KPCS requires the establishment of national legislation and institutional controls, and control of imports and exports as minimum requirements, it does not provide guidance on how to implement these requirements. Each country therefore develops its own control mechanism. However, the objectives are the same.

For example: In Belgium all rough diamonds are inspected by diamond experts. The inspections are supervised by government inspectors (Department of Federal Public Service Economy) in the presence of customs officials (33).

In the United States, “The Clean Diamond Trade Act” authorizes the President of the United States to prohibit imports and exports of rough diamonds that have not been controlled through the Kimberley Process Certification Scheme.

In Canada, there is legislation (34) that requires the inspection of rough diamonds to be jointly carried out by government inspectors and customs officials, in order to ensure that exports comply with the Kimberly Process Certification, and that packages destined for exports are sealed for control purposes. Furthermore, an independent audit is performed for tax purposes.

Selected best practices and outcomes from the Diamond industry:

- i) The KPCS requires inspection of rough diamonds.
- ii) The KPCS requires export control of rough diamonds.
- iii) The KPCS requires its members to certify that shipments of rough diamonds are ‘conflict-free’. This is similar to the NPT requiring that export of uranium is conditional on the importer having a safeguards agreement that covers the uranium. To further strengthen this requirement would need something like the ban on re-exporting that is part of the CWC.

CHAPTER 3 CHALLENGES AND WEAKNESSES IDENTIFIED IN THE CURRENT NPT SAFEGUARDS MODEL FOR THE FRONT END OF THE NFC IN AFRICA

Challenge #1

Nine African countries with safeguards agreements have not concluded Additional Protocol with the IAEA, including one (Zambia) with significant uranium resources. Without the Additional Protocol, the State does not make declarations about the following NFC front end activities: location and annual production of uranium mines and uranium concentration plants.

Furthermore, 10^{vi} African countries have not concluded safeguards agreement with the IAEA.

Challenge #2

Many African States, including some with significant uranium resources, either do not have a nuclear legislative framework, or have one that is not fully functional and competent in carrying out the commitments in safeguards agreements; or controlling nuclear energy as required by their national laws and regulations.

In Namibia for example, there is no legal framework because their national nuclear fuel cycle policy is yet to be approved by Government before any safeguards regulatory authority could be commissioned. The safeguards regulatory authority function is currently imbedded under the ministry of science and social health.

Challenge #3

Seven out of nine African countries with significant uranium resources do not have safeguards regulatory authorities that are independent from the entities being regulated. In order for any regulatory authority to be effective and credible, it has to be independent of the regulated entity. Most nuclear regulatory authorities in Africa are not independent – either existing as part of government ministries and/or having ownership or other vested interest in the regulated entities. The independence of the regulatory body would strengthen its oversight of all nuclear-related facilities and activities in the country.

In South Africa for example, regulatory functions related to safeguards (35) have been delegated to the South African Nuclear Energy Cooperation (NECSA). This introduces a conflict of interest as the safeguards regulatory authority (NECSA) is a referee and player at the same time.

Challenge #4

Article III.2 of the NPT requires States not to export uranium ore concentrate (UOC), unless the UOC will be subject to safeguards in the importing State. However, although implementation of the current safeguards model requires qualitative reporting of exports/imports (INFCIRC/153 paragraphs 34 a) and b)), it does not require verification of uranium ore concentrate subject to export/import (INFCIRC/153, para. 33).

Challenge #5

The present safeguards model does not require detailed accountancy for the reporting of imports and exports of uranium ore concentrate (to non-nuclear weapon States). The accountancy of the reporting is not required to be better than estimates, and the reporting is only limited to transactions related to the nuclear fuel cycle.

Challenge #6

Many African national regulatory authorities either do not report or do not have the capacity to report the following information on exports & imports of uranium ore concentrate as required by paragraphs 34) and b) of the model safeguards agreement: Quantity, composition and origin/destination of the material.

Challenge #7

Many African national regulatory authorities either do not declare or do not have the capacity to declare the following information as required by Article 2.a. (v) of their Additional protocol: Information specifying the location, operational status and the estimated annual production capacity of uranium mines and concentration plants, or the estimated current annual production of such mines and concentration plants for the State as a whole.

Challenge #8

The current safeguards model (paragraph 33 of the model safeguards agreement) exclude uranium ore concentrates from safeguards verification activities. This means that the amount of uranium that can potentially be introduced into NFC facilities is not known with high confidence. This opens the door for potential undeclared production for possible proscribed purposes.

Challenge #9

Seven out of twenty six African countries with Small Quantity Protocol (SQP) have not modified or rescinded their SQP, including some with significant uranium resources. Without the modified SQP, there is no mechanism for reporting or for controlling and monitoring nuclear materials on the territory of a State.

Challenge #10

Under the current safeguards model, there is no safeguards regulatory coverage of non-uranium ores with a high content of uranium e.g. Cobalt ores in DRC, Copper ores in DRC and Zambia, phosphates in Senegal, Tunisia and Morocco. An important challenge that safeguards is facing at the front end of the nuclear fuel cycle concerns non-uranium ores that co-exist with uranium and/or contain uranium. There are reportedly several cases (36) in which non-uranium ores with high uranium content are purchased, not for non-uranium content, but for the uranium. Such non-uranium ores are currently not subject to any type of safeguards obligations.

Challenge #11

Not all African States are members of the IAEA.

If a country is not a member of the IAEA, it cannot participate in, and benefit from many opportunities available through the IAEA to strengthen its nuclear regulatory infrastructure, and to acquire nuclear related skills and technology; all of which have an impact on non-proliferation.

CHAPTER 4 PROPOSALS FOR STRENGTHENING CONTROLS AT THE FRONT END OF THE NUCLEAR FUEL CYCLE

Based on the review and analysis of information carried out in this research project, a number of solutions were identified for addressing the challenges listed in chapter 3 above. These solutions can be classified into the following fourteen generic headings:

- Collective Safeguards Agreements
- Additional Protocols
- Nuclear regulatory Frameworks
- Export Controls
- AFCONE
- Scope of nuclear material accountancy
- Advance notification of UOC exports
- Time limits for the resolution of questions
- Challenge safeguards inspections
- Confidence building measures
- Declaration of historical nuclear fuel cycle activities
- IAEA Membership
- Nuclear Security solutions

4.1 Collective Safeguards Agreements

African countries should subsume their current safeguards agreements into a single collective safeguards agreement.

Article III.4 of the NPT allows a grouping of States to collectively conclude safeguards agreements with the IAEA. A collective safeguards agreement for African States could subsume all the individual safeguards agreements in Africa, as is the case in EURATOM, where INFCIRC/193 has subsumed all individual country safeguards agreements. This would simplify the administrative aspects of safeguards implementation, and it would enhance cooperation and exchanges between African countries.

Challenges that are addressed through collective safeguards agreements

Challenge #6

Many African national regulatory authorities either do not report or do not have the capacity to report the following information on exports & imports of uranium ore or uranium ore concentrate as required by paragraphs 34) and b) of the model safeguards agreement: Quantity, composition and origin/destination of the material. With the creation of AFCONE under the Pelindaba Treaty, African countries now have the opportunity to subsume all their existing safeguards agreements into a single safeguards agreement, with AFCONE as the regional safeguards authority. The competence of AFCONE derived from drawing expertise and resources from all States, and the involvement of AFCONE in every State in its capacity as a regional regulatory authority would offset incompetence in individual national authorities and develop capacity in individual national regulatory authorities to be able to carry out their safeguards reporting obligations for uranium ore concentrate.

Challenge #9

Not all African countries with Small Quantities Protocol (SQP), including some with significant uranium resources, have modified or rescinded their SQP. Without the modified SQP, there is no mechanism for reporting or for controlling and monitoring nuclear materials on the territory of a State.

A single “regional” safeguards agreement would eliminate the problem of un-modified SQP because since 2007, all new NPT safeguards agreements concluded with the IAEA must be either the modified SQP or the full comprehensive safeguards agreement.

Challenge #2

Many African States, including some with significant uranium resources, either do not have a nuclear legislative framework, or have one that is not fully functional.

A collective safeguards agreement implies a multilateral regulatory authority. This would eliminate the need for individual countries to urgently establish regulatory authorities, as these functions would be delegated to AFCONE.

4.2 Additional Protocols

States without Additional Protocols in force should make efforts (and be encouraged) to sign and/or bring Additional Protocols into force.

Without the Additional Protocol, the State does not make declarations about the following NFC front end activities: location and annual production of uranium mines and uranium concentration plants. The general safeguards agreement only has provision for the reporting of export and import (transactions of uranium ore concentrates), but not the locations and the production capacities of the mines and concentration plants. Declarations under the additional protocol will therefore provide more information about the front end of the State's nuclear fuel cycle.

Challenges that are addressed through Additional Protocols:

Challenge #1

Not all African countries with safeguards agreements, including one (Zambia) with significant uranium resources have an Additional protocol in force with the IAEA.

Challenge #5:

The reporting of imports and exports of uranium and uranium ore concentrate (to non-nuclear weapon States) required by paragraphs 34 a) and b) of the model safeguards agreement INFCIRC/153 is only limited to transactions related to the nuclear fuel cycle.

The Additional Protocol includes provision for the reporting of exports and imports for non-nuclear purposes - AP (Article 2.a. (vi). (b) and (c).

4.3 Nuclear Regulatory Framework

- States without nuclear regulatory frameworks should make efforts to establish one.
- States with national nuclear regulatory authorities that lack the expertise or resources to carry out their functions should make every effort to remedy the situation.

A functioning regulatory framework is a fundamental requirement for the effective implementation of international safeguards. Hence, when a State brings a safeguards agreement into force, one of the first requirements is for the State to establish a State System for Accounting and Control of nuclear materials (SSAC). (Paragraph 7 of the model safeguards agreement, INFCIRC/153). This is because the Agency cannot establish and run an accounting system for each facility in each country under safeguards. That would be very costly, inefficient and infringe on the sovereignty of the State. The solution is to implement safeguards via the SSAC which is usually hosted at the national regulatory authority.

Establishment of an SSAC also strengthens the framework for carrying out domestic safeguards, carrying out nuclear security measures and managing nuclear energy in general. It is therefore important that the SSAC is established, that there is a designated point of contact with the IAEA that the SSAC participates in relevant training courses under the auspices of the IAEA, and also benefits from IAEA outreach missions such as the ISSAS mission. It is also important that the SSAC takes advantage of regional initiatives in Africa, for example under the auspices of AFRA, and also to collaborate with other entities such as the US NNSA and the British VERTIC that are involved in building SSAC capacity around the world.

States needing to establish a nuclear regulatory framework or to improve an existing system may request assistance to do so from the IAEA, through joining the Forum of Nuclear Regulatory Bodies in Africa (FNRBA) which was established in 2009, through AFCONE or through cooperation with other countries.

In the case of the IAEA, the State may request from the IAEA the IAEA SSAC Advisory Service (ISSAS), which provides requesting national authorities with recommendations and suggestions for improvements to their State systems for accountancy and control (SSACs) of nuclear material.

The missions evaluate the regulatory, legislative, administrative and technical components of the SSAC at both the State and facility level, and assess how the SSAC meets the obligations contained in the State's safeguards agreement and additional protocol as applicable.

Article 8.3 of the Pelindaba Treaty encourages parties to make use of the programme of assistance available in IAEA and, in this connection, to strengthen cooperation under the African Regional Cooperation Agreement for Research, Training and Development Related to Nuclear Science and Technology (hereinafter referred to as AFRA).

Challenges that are addressed through Nuclear Regulatory Frameworks:

Challenge #2

Many African States, including some with significant uranium resources, either do not have a nuclear legislative framework, or have one that is not fully functional.

4.4 Export Controls

All African countries with uranium resources should establish export control regimes in accordance with the international export guidelines (37) such as the Nuclear Suppliers Group.

Establishment of export controls stems from the requirement in most of the multilateral agreements reviewed in this research project to prohibit export of the subject item, unless the item exported is covered by verification arrangements. Export control is part of the NPT, as well as the Pelindaba Treaty. Also introducing restrictions on re-export would strengthen any export control regime.

Article III.2 of the NPT requires States not to export uranium ore concentrate (UOC), unless the UOC will be subject to safeguards in the importing State; but IAEA safeguards do not include verification of UOC. Therefore, this NPT requirement cannot be verified through IAEA safeguards. The Pelindaba Treaty also includes text requiring comprehensive safeguards in the importing country. This is a more stringent requirement than the model IAEA safeguards agreement.

Under Pelindaba, States with the potential to use imported material in activities that are not covered by safeguards will not be able to import African UOC. The document specifying how AFCONE would verify compliance with the Pelindaba Treaty has not yet been written. If the Pelindaba Treaty follows the example of EURATOM, AFCONE would have the power to monitor exports of UOC in Africa.

Challenges that are addressed through Export Controls:

Challenge #4

Article III.2 of the NPT requires States not to export uranium ore concentrate (UOC), unless the UOC will be subject to safeguards in the importing State.

4.5 Scope of Nuclear Material Accountancy (NMA)

African States could unilaterally or jointly under AFCONE choose to extend detailed NMA to uranium ore concentrates, as well as to other uranium containing ores.

As regards uranium ore concentrates, the current safeguards model requires only qualitative reporting of exports, it does not include verification of exports of uranium ore concentrate.

That is because the practice under the current safeguards model is to begin detailed NMA at the conversion plants, where the converted material is classified as meeting the purity requirements of paragraph 34c of the model safeguards agreement. Detailed material accountancy is therefore not applied to UOC; thus making UOC a potential loophole for the clandestine acquisition of nuclear material under NPT safeguards.

Some producers of uranium ore concentrates are advertising the product of their concentration plants as directly suitable for fuel fabrication, i.e. without further processing in a conversion plant.

Furthermore, there is also an understanding that the technical requirements of a potential proliferator are likely to be less strict than those of the commercial nuclear industry.

Additionally, there are other uranium containing minerals that are of concern on the African continent. Phosphates in Morocco have high uranium content and have been reportedly purchased for their uranium content without declaration to the IAEA. Senegal and Tunisia also has phosphates that are rich in uranium. The DRC has copper and Nickel ores that are rich in uranium. The Shinkolobwe uranium mine in the Katanga Province of the DRC that is presently shut down by government order has reportedly been unofficially mined since 1997 for cobalt. A UN report in 2004 described the situation as anarchistic. This has prompted some concern by the International Atomic Energy Agency on account of the possibility that some uranium might be finding its way to countries with illicit weapons programs. In the south-eastern region of Katanga the geology is contiguous with the Zambian copper belt.

While the Pelindaba Treaty only endorses NPT safeguards by the IAEA, African States could unilaterally or jointly under AFCONE choose to extend detailed NMA to uranium ore concentrates.

Challenges that are addressed through extending detailed NMA to UOC.

Challenge #4

Article III.2 of the NPT requires States not to export uranium ore concentrate (UOC), unless the UOC will be subject to safeguards in the importing State. However, although implementation of the current safeguards model requires qualitative reporting of exports, it does not include verification of exports of uranium ore or uranium ore concentrate.

Challenge #10

Under the current safeguards model, there is no safeguards regulatory coverage of non-uranium ores with a high content of uranium. An important challenge that safeguards is facing at the front end of the nuclear fuel cycle concerns non-uranium ores that co-exist with uranium and/or contain uranium. There are reportedly several cases (36) in which non-uranium ores with high uranium content are purchased, not for non-uranium content, but for the uranium. Such non-uranium ores are currently not subject to any type of safeguards obligations.

4.6 Universal reporting of Exports

African countries should voluntarily opt to report all exports of uranium ore concentrates, irrespective of the end use or the destination.

The reporting of exports of uranium ore concentrates required by paragraphs 34 a) and b) of the model safeguards agreement, apart from being mainly qualitative as described above, only applies to transactions related to the nuclear fuel cycle (as reported by the importer) and also only applies to transactions involving non-nuclear weapon States.

4.7 AFCONE

All African countries that are parties to the Pelindaba Treaty should participate in AFCONE and support the establishment of a Secretariat for AFCONE.

In formulating the solutions, it was realized that most of the proposals can be facilitated through AFCONE, based on the responsibilities assigned to AFCONE in the Pelindaba Treaty. Furthermore, AFCONE, by not being part of any individual government, will have the independence necessary to effectively carry out its functions.

In order for AFCONE to be able to independently and effectively fulfil the role of a regional nuclear regulatory authority, it would have to be invested with the appropriate supranational authority, and it would have to establish its own Secretariat as foreseen in Annex IV.5 of the Pelindaba Treaty. In the case of Latin America, two of the countries, Brazil and Argentina, took the initiative to create such a secretariat to carry out the safeguards provisions of the treaty. This is also reminiscent of the NPT, where a number of States party to the treaty took the initiative to create the nuclear suppliers Group (NSG) in order to be able to implement the provisions of Article III.2 of the NPT.

Challenges that are addressed through establishing a secretariat for AFCONE.

Challenge #2:

Many African States, including some with significant uranium resources, either do not have a nuclear legislative framework, or have one that is not fully functional.

Challenge #3:

Many African States, including some with significant uranium resources have a nuclear regulatory authority, but not one that is independent from the entities being regulated.

Challenge #6

Many African national regulatory authorities either do not report or do not have the capacity to report the following information on exports & imports of uranium ore or uranium ore concentrate as required by paragraphs 34) and b) of the model safeguards agreement: Quantity, composition and origin/destination of the material.

Challenge #7

Many African national regulatory authorities either do not declare or do not have the capacity to declare the following information as required by Article 2.a. (v) of their Additional protocol: Information specifying the location, operational status and the estimated annual production capacity of uranium mines and concentration plants, or the estimated current annual production of such mines and concentration plants for the State as a whole.

4.8 Advance notification of UOC shipments

African States should include in their nuclear legislative framework, the requirement to notify the IAEA (and/or AFCONE) of exports of UOC, and to request verification of the material before expedition.

Proposal #4.5 recommends the application of detailed NMA to UOC. In order to effectively implement detailed accountancy on UOC, it would be necessary to require advance notifications of shipments. This is a best practice within the framework of the CWC. To incorporate it in NPT safeguards would not need a separate negotiation, as long as it has been agreed to apply detailed accountancy to UOC. It would just be a measure to enable the detailed accountancy. Advance notice allows verification of the material before the shipment.

Challenges that are addressed through Advance Notification of UOC exports

Challenge #4

Article III.2 of the NPT requires States not to export uranium ore concentrate (UOC), unless the UOC will be subject to safeguards in the importing State. However, although implementation of the current safeguards model requires qualitative reporting of exports, it does not include verification of exports of uranium ore or uranium ore concentrate.

Challenge #8

The current safeguards model (paragraph 33 of the model safeguards agreement) exclude uranium ores and uranium ore concentrates from safeguards verification activities. This means that the amount of material that can potentially be introduced into NFC facilities is not known with high confidence. This opens the door for potential undeclared production for possible proscribed purposes.

4.9 Time limits for the resolution of questions

If the IAEA raises a question regarding alleged non-compliance or undeclared materials and activities, there is no timeline in NPT safeguards for the resolution of the question. This is a disadvantage because there are situations that are time sensitive from a proliferation stand point. Some of the other verification regimes including the Pelindaba treaty (Annex IV); have time limits for the resolution of questions. The only drawback of the litigation process under the Pelindaba Treaty is that the time frames may be too long for some safeguards scenarios. Such weaknesses may be resolved in revisions of the Treaty in accordance with Article 19 of the Pelindaba Treaty (Amendments).

4.10 Challenge safeguards inspections

Challenge inspections are defined as a scenario where one State can request an inspection at any location in another State. Such a provision does not exist in NPT safeguards. It exists in other verification regimes such as CTBT and CWC. In the case of the Pelindaba Treaty, one State cannot directly force an inspection on another State; however Annex IV of the Treaty allows a State to take a complaint to AFCONE and AFCONE can force the inspection if it is not satisfied by the resolution of the complaint provided by the State complained of. The idea of challenge inspections adds another level of ensuring compliance by empowering member States to be vigilant about what their neighbours are doing within the framework of the treaty. In some ways, this is analogous to the idea of ABACC where Brazil and Argentina have agreed to monitor each other.

4.11 Confidence Building measures

Voluntary Reporting could be included in the arrangements for verification of compliance between AFCONE and State parties to the Pelindaba Treaty.

Confidence Building measures exist in the CTBTO and in the JCPOA, but not in NPT safeguards. In the early 1990s, a Voluntary Reporting Scheme, which was essentially a confidence building measure, was introduced in NPT safeguards, but that has since been mostly discarded because its scope was narrow, and is covered by the Additional Protocol. However, the idea of Voluntary Reporting could be beneficial, especially if the onus is on the State to report based on its own assessment. Although, there is no provision for voluntary reporting in the Pelindaba Treaty, voluntary reporting can be introduced as an implementation strategy in the achievement of the Pelindaba objectives. This type of mechanism is not uncommon in NPT safeguards where, in cases where interpretation of, or translation of the text of the agreement into practices not obvious, Policy papers and other types of documents that carry legal authority are developed to address the situation.

4.12 Declaration of Historical Nuclear Fuel Cycle Activities

Declaration of historical NFC front end activities could be included in the arrangements for verification of compliance between AFCONE and State parties to the Pelindaba Treaty.

Under the CWC, States are required to declare information on past activities related to the subject of the Treaty. This requirement is not required under NPT safeguards, but in the practice of NPT safeguards information on past nuclear activities is often requested to resolve questions. Hence, it is a powerful best practice that would enable pre-emption of future problems.

4.13 IAEA membership

African States not yet members of the IAEA should apply for membership of the IAEA.

Article 8.3 of the Pelindaba Treaty encourages Parties to make use of the programme of assistance available in IAEA.

Without IAEA membership, a State cannot participate in, and benefit from many opportunities available through the IAEA to (inter alia) strengthen its nuclear regulatory infrastructure; to acquire nuclear related skills and technology; and to develop measures that will combat incidents related trafficking of nuclear material; all of which have an impact on non-proliferation. E.g. Portal monitors at the port of entry to detect if any nuclear material is trafficked through the borders.

4.14 Nuclear Security solutions (NS solutions)

Nuclear security and safeguards are closely related. In general terms, they both involve activities to ensure that nuclear material is where it should be and is not used for non-peaceful purposes. At the present time, implementation of safeguards and nuclear security are completely divorced from one another. Integrating safeguards and nuclear security measures under the same verification regime, for example through AFCONE, would greatly enhance the effectiveness of each one. (The whole is greater than the sum of the parts).

NS solution #1:

Strengthen government regulation and control of the mining and transportation of mineral ores. In the DRC for example, Law No. 017/2002, requires mining firms in the Katanga province to be inspected by the CGEA before they export ores, in order to verify whether or not any radioactive substances are contained in the ores. This is not yet implemented as the CGEA does not yet have a laboratory to do such verification.

By becoming a member of the IAEA, regulatory framework can be developed as per country's needs and also infrastructure review assessments performed by the Agency upon member States' request.

IAEA assistance is provided through National training course on nuclear security for the uranium extraction industry. The purpose of the training is to strengthen the nuclear security regimes across national governments and be able to provide recommendations with regard to nuclear security in the uranium industries.

NS solution #2:

The State will need to build human capacity (via training of customs officials and border police) in the detection of radioactive materials. The State will also need to procure/obtain portable (hand held) radiation detectors/monitors and portal monitors for this purpose.

Assistance for capacity building and acquisition of equipment may be requested through the IAEA; or directly through such programmes as the US Mega ports initiative. These systems will be deployed at airports, seaports and land crossings.



RIDs

Figure 6: Examples of Radioisotope Identification Devices (RIDs)



Figure 7: Examples of Radioisotope Identification Devices (RIDs)

It all starts here™

NS SOULUTIONS #3

Improve physical protection at facilities and other places handling nuclear and radioactive materials.

The IAEA may provide advice and assistance on physical protection measures such as:

- Fencing/double fencing with fiber optic sensors
- Video system with external light
- Access control
- Perimeter Intrusion detection system (microwave)
- Sensors and video at selected building entrances and exits.
- Central alarm station
- Hardened doors and dual door locks
- Siren and visual alarm panels
- Glass break detectors
- Vehicle barriers at facility access points.
- Motion detection systems (microwave, video, IR beam)
- Penetration sensors
- Portal monitors for vehicles entering and exiting the facility.
- Hand held radiation detectors at entry and exit points.



Figure 8: Double fencing and surveillance cameras – Physical Protection/Nuclear Security measures

NS solution #4:

African States to enact legislation that prioritizes joining the ITDB.

The IAEA regularly sends out corresponding requesting IAEA member States to participate in the Illicit Trafficking Data Base (ITDB).

Develop or seek assistance to develop emergency preparedness for incidents related to the trafficking and transportation of radioactive materials, nuclear materials and uranium ore concentrates (UOC) and other relevant mineral ores.

Measures that a State may use to combat illicit trafficking of nuclear materials include monitoring of national land, sea and air borders, development of human resources in the detection and identification of nuclear materials, and the use of advanced technologies such as satellite and radar imaging.

Make use of satellite imagery to monitor mineral exploration and exploitation activities, and the movement of minerals in the country and across national borders. The two types of satellite imagery mostly used in this type of activity are:

- Optical Satellite Imagery; and
- Radar Satellite Imagery.

Satellite imagery upon specific request is expensive, but there are many providers (including the European Union) of free archive satellite imagery. Google Earth is also a resource that may be used at no cost.

Optical Satellite Imagery has traditionally been the mainstay of satellite imagery monitoring, but in recent years, radar satellite imagery is increasingly coming into play.

Radar imagery has certain advantages over optical imagery – for example: Radar imagery does not need sunlight and hence can be taken at night time; the phase properties of radar allow the automatic identification in movement that cannot be detected by optical imagery – such as changes in topology etc. – which are strong indicators of activity.

CHAPTER 5 CONCLUSION

The purpose of this research project as described in the introduction is to support the Non-Proliferation regime by investigating and proposing ideas on how to improve assurances that the front end of the nuclear fuel cycle (NFC) in Africa is not used to support non-peaceful purposes.

The project reviewed the current safeguards model for monitoring and verifying the front end of the nuclear fuel cycle – specifically uranium mining and uranium ore processing, and identified weaknesses and challenges which if addressed would strengthen the current safeguards regime.

The project further assessed that to better protect uranium resources from diversion, malicious acts, sabotage, unauthorized access, theft and terrorism, requires inter alia, the establishment of a multi-component approach including: Safeguards, Nuclear Security, National Regulatory and Administrative Frameworks, Regional Collaboration and International Cooperation.

The project therefore also reviewed other regulatory frameworks, other verification regimes, and other mineral industries, in order to identify best practices that may be adopted to strengthen and expand the present safeguards system.

In order to be able to fully integrate the best practices and other ideas for improvement into the monitoring and verification of the front end of the nuclear fuel cycle in Africa, the project also reviewed the nuclear regulatory frameworks of selected African countries (countries with significant uranium resources) as well as other non-proliferation related multilateral commitments undertaken by these countries.

The work carried out in this project culminated in a number of proposals (Section 4) for strengthening non-proliferation assurances related to uranium mining and uranium ore processing and transportation on the African continent (without the negotiation of any new legal instruments).

These proposals have been grouped under the following generic headings: Collective Safeguards Agreements, Additional Protocols, Nuclear regulatory Frameworks, Export Controls, AFCONE, Scope of nuclear material accountancy, Advance notification of UOC exports, Time limits for the resolution of questions, Challenge safeguards inspections, Confidence building measures, Declaration of historical nuclear fuel cycle activities, IAEA Membership and Nuclear Security solutions.

It was assessed that implementation of these proposals could be best facilitated through AFCONE – the compliance arm of the Pelindaba Treaty (that is in the process of being fully established). This would be enabled by African countries or groups of African countries subsuming their present individual safeguards agreements into a collective safeguards agreement(s) under AFCONE as a regional regulatory authority, as is the case in EURATOM, where INFCIRC/193 has subsumed all individual country safeguards agreements – except in the nuclear weapon States, France and the UK.

AFCONE, working as a regional regulatory authority, invested with the appropriate supranational authority, would simplify the administrative aspects of safeguards implementation; it would enhance cooperation and exchanges between African countries. Enhanced cooperation between States would also introduce transnational coordination in the control of the transport of mineral ores. AFCONE would further help to bridge the regulatory gaps presently existing on the African continent. This would make sense considering that most African countries are looking at developing nuclear power, not individually, but as joint ventures (38). A regional regulatory authority also responsible for nuclear material accountancy at jointly owned power plants (and other nuclear fuel cycle facilities) would not only ensure that the system works but would also benefit conformity to nuclear security norms.

It is hoped that the work carried out in this project will stimulate further research in non-proliferation issues (in Africa), and will inform policy initiatives on the important topic of nuclear non-proliferation.

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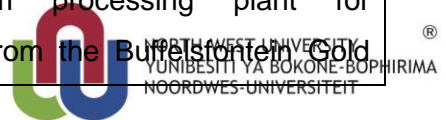
Annex 1: African countries with significant uranium resources

COUNTRY	URANIUM RESOURCES	MINING & MILLING
Democratic Republic of Congo (DRC)	About 25,000 tU was produced in the DRC during the period from 1940 – 1960.	<p>The DRC provided much of the uranium for the Manhattan Project in the early 1940s particularly from the Shinkolobwe mine in the Katanga Province.</p> <p>Uranium exploitation is presently forbidden in the DRC by Presidential Decree⁴ since 2004, and there are currently no officially operating uranium mines in the DRC.</p> <p>However, artisanal uranium mining is reportedly taking place in the DRC⁵.</p>
Niger	<p>Niger has (estimated) known recoverable uranium reserves of 404,000 tonnes – about 7% of the world's known recoverable reserves.</p> <p>Currently, Niger is the world's fourth-ranking producer of uranium.</p>	<p>Niger has two AREVA operated uranium mines – Compagnie Minière d'Akouta (COMINAK) and Société des Mines de l'Air (SOMAIR) - providing 7.5% of world mining output from Africa's highest grade uranium ores.</p> <p>The SOMAIR mine currently produces about 2300 tU/yr, while the COMINAK mine currently produces about 1500 tU/yr.</p> <p>A third mine, the SOMINA uranium mine is operated by the Chinese National Nuclear Corporation (CNNC).</p> <p>A fourth uranium mine, the Imouraren mine currently under development (Suspended) by AREVA is estimated to produce up to 5000 tU/yr for 35 years when it comes into</p>

⁴ Presidential Decree No. 04/17, January 27, 2004

⁵ 2013-06-11_Activists in the DRC claim illegal mining at Shinkolobwe Uranium Mine.pdf

COUNTRY	URANIUM RESOURCES	MINING & MILLING
		<p>operation. It will be the largest open pit uranium mine in Africa and the largest anywhere in the world using heap leaching.</p> <p>There are presently several new uranium mine prospects under assessment/exploration by various companies.</p>
Namibia	Namibia has estimated recoverable uranium reserves of 382,000 tonnes – about 6% of the world's known recoverable reserves.	<p>Currently, three uranium mines are in operation in Namibia. Rössing, Langer Heinrich and Trekkopje. Rössing is the world's longest running open pit uranium mine.</p> <p>There are several promising developments in Namibia, including the major Husab project, which promises to become one of the world's largest uranium mines. It is owned by a subsidiary of CGN, China's largest nuclear power operator.</p>
South Africa	South Africa has estimated recoverable uranium reserves of 338,000 tonnes – about 6% of the world's known recoverable reserves.	<p>South Africa's uranium is recovered as a by-product from the treatment of gold-bearing and copper-bearing ores. Sibanye Gold in the west rand has a uranium processing plant, producing uranium from Cooke-3 and 4(former Ezulwini) gold shafts. AngloGold Ashanti has a uranium processing plant (South U-plant) in the Vaal Reefs area where the main feed comes from Kopanong, Great Nolingwa, and Moab Kgotsong gold mines. Less than 50km away from Vaal Reefs in a town called Stilfontein, where there is a Mine Waste Solution uranium processing plant for historical tailing from the Buffelstfontein Gold</p>



COUNTRY	URANIUM RESOURCES	MINING & MILLING
		<p>mines.</p> <p>Uranium ore concentrate in the form of ammonium diuranate(ADU) produced from all uranium plants in South Africa is tanked and transported by road to NUFCOR(owned by AngloGold Ashanti) for further processing</p>
Tanzania	Tanzania has estimated recoverable uranium reserves of 58,000 tonnes – about 1% of the world's known recoverable reserves.	There are presently no uranium mining operations in Tanzania. The Tanzanian government has requested IAEA assistance to bring its relevant legislation and procedures in line with safety and environmental standards and to make sure that good practices are applied ahead of the commencement of mining operations.
Central African Republic	Inferred uranium resources at Bakouma were estimated at 36,475 tU at the end of 2013. 90% owned by AREVA and 10% by the government	No uranium mining or milling operations are presently taking place. UraMin Inc. of Toronto was expected to start operating the open pit mine in Bakouma with envisaged production of 1200tU/yr. with ore grading of 1.27%U. in 2014-2015, further development of the mine was suspended due to low uranium prices.
Malawi	In 2012, IAEA statistics ⁶ showed Malawi in the world's top ten uranium producers – with 2% of	In Malawi, Paladin Energy has developed the Kayelekera uranium mine where production reached 1100 tU/yr before being suspended in 2014 due to non-profitability of the operation because of the depressed price of uranium. It

It is available at <http://www.iaea.org/OurWork/ST/NE/NEFW/Technical-Areas/NFC/uranium-production-cycle-redbook.html>

COUNTRY	URANIUM RESOURCES	MINING & MILLING
	the world's production.	<p>is assessed that the mine would only be profitable at a uranium price of ~ 150 \$/kg.</p> <p>Uranium mining projects under development include: The Kanyika Niobium Project, operated by Globe Metals & Mining; the Livingstonia uranium project, owned by Resource Star Ltd; and the Thambani uranium exploration project owned by Mkango Resources Ltd.</p>
Botswana	Botswana has estimated recoverable uranium reserves of 68,000 tonnes – about 1% of the world's known recoverable reserves.	<p>According to the Ministry of Minerals of Botswana, 138 prospecting licences have been issued for the exploration of uranium across Botswana⁷</p> <p>There is presently no operating mine in Botswana, however the Letlhakane uranium project managed by the Australian company, A-Cap Resource Limited is at advanced stage. Production at about 1350 tU/yr is envisaged⁸</p>
Zambia	Zambia has estimated identified conventional uranium resources of 38,685 tonnes.	<p>There is currently no uranium mining, however uranium explorations is being performed in Chirundu and other areas.</p> <p>The Lumwana copper mine in the Zambian Copper belt also hosts significant uranium resources and uranium is mined concurrently. The plan to develop uranium process plant was put on hold due to low uranium price.</p>

ENDNOTES

- i IAEA safeguards model for the structure and content of safeguards between the Agency and State required in connection with the treaty on the Non-Proliferation of nuclear Weapons.
- ii States participating in the ITDB as of 31 December 2015: <https://www-ns.iaea.org/downloads/security/itdb-fact-sheet.pdf>
- iii The JCPOA is an agreement between Iran and the 5 permanent members(Russia, china, France, United Kingdom and United States of America of the UN Security Council and Germany that was signed in July 2015, for the verification and monitoring of Iran's nuclear programme.
- iv A nuclear weapon free zone treaty as defined by UN Disarmament Commission in its report of April 30, 1999.<https://www.un.org/disarmament/wmd/nuclear/nwzf/>
- v The twenty eight countries that ratified the Pelindaba Treaty to enter into force are Algeria, Benin, Botswana, Burkina Faso, Burundi, Cote d'Ivoire, Equatorial Guinea, Ethiopia, Gabon, Gambia, Guinea, Kenya, Lesotho, Libyan Arab Jamahiriya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Nigeria, Rwanda, Senegal, South Africa, Swaziland, Togo, United Republic of Tanzania, and Zimbabwe. James Martin Centre of Nonproliferation studies, August 12, 2009, <https://www.nonproliferation.org/africa>
- vi The ten African countries that have not concluded safeguards agreement with IAEA are Somalia, South Sudan, Sao Tome and Principe, Liberia, Guinea, Guinea, republic of Eritrea, Equatorial Guinea, Cabo Verde, and Benin as of 2017-07-01, IAEA intranet.