

**The Republic of Ghana**  
**National Report for the Joint Convention on the**  
**Safety of Spent Fuel Management and on the Safety of Radioactive Waste**  
**Management**

**Fourth Report**

**October 2020**

## **Table of Contents**

Section A. INTRODUCTION .....	1
A.1.0 Background .....	1
A.1.1 Provisions of the Joint Convention .....	2
A.2.0 Purpose of this Report.....	3
A.2.1 Structure of this Report.....	3
A 3.0 Issues Arising From The 6 <sup>th</sup> Review Meeting .....	4
Section B – POLICIES AND PRACTICES .....	5
B.1 Article 32.1: Reporting.....	5
B.1.1 Radioactive Waste Management Policy Framework .....	5
B.1.2 Spent fuel management policy .....	6
B.2 Radioactive Waste Management Practices .....	6
Section C. SCOPE OF APPLICATION .....	9
C.1: Article 3. Scope of Application .....	9
Section D. INVENTORIES AND LISTS .....	10
D.3 Radioactive Waste Management Facilities .....	10
D.4 Inventory Of Radioactive Waste.....	12
Section E. LEGISLATIVE AND REGULATORY SYSTEM.....	13
E.1 Implementing Measures .....	13
E.2 Legislative And Regulatory Framework.....	13
E.2.2. Regulatory Framework.....	14
E.3 The Establishment of a Regulatory Body .....	18
E.3.1. Nuclear Regulatory Authority .....	18
E.3.2. Organisational Structure of Nuclear Regulatory Authority .....	18
Section F. GENERAL SAFETY PROVISIONS .....	22
F.1 Responsibility of the Licence Holder.....	22
F.2 Human and Financial Resources .....	23
F.3: Quality Assurance .....	24

F.4 Operational Radiation Protection.....	26
F.4.1. Dose Limits .....	27
F.5. Emergency Preparedness .....	28
F.6 Decommissioning .....	28
Section G. SAFETY OF SPENT FUEL MANAGEMENT .....	30
G.1 General Safety Requirements.....	30
G.1.2. The Generation of Radioactive Waste Associated with Spent Fuel Management .....	31
G.1.3. Interdependencies Among the Different Steps in Spent Fuel Management.....	31
G.1.4. Effective Protection of Individuals, Society and The Environment by Application of Protective Methods as Approved by The Regulatory Body.....	31
G.1.5. Biological, Chemical and Other Hazards Associated with Spent Fuel Management.....	31
G.1.6. Avoidance of Actions That Impose Reasonably Predictable Impacts on Future Generations Greater Than Those Permitted for The Current Generation.....	32
G.1.7. Aim to Avoid Imposing Undue Burdens on Future Generations.....	32
Section H. SAFETY OF RADIOACTIVE WASTE MANAGEMENT .....	34
H.1 General Safety Requirements.....	34
H.1.1. Criticality and Residual Heat Removal .....	34
H.1.2. Minimisation of Radioactive Waste.....	35
H.1.3. Interdependencies in Radioactive Waste Management .....	35
H.1.4. Protection of Individuals, Society and the Environment.....	35
H.1.5. Biological, Chemical and Other Hazards .....	36
H.1.6. Protection of Future Generations .....	36
H.1.7. No Undue Burden on Future Generations.....	37
H.2 Existing Facilities and Past Practices .....	37
H.2.1. Safety of Existing Radioactive Waste Management Facilities.....	37
H.3 Siting of Proposed Facilities.....	38

H.3.2. Evaluation of The Safety Impact of a Facility on Individuals, Society and The Environment, After Closure.....	39
H.4 Design and Construction of Facilities.....	39
Section I. TRANS-BOUNDARY MOVEMENT.....	41
Section J. DISUSED SEALED SOURCES.....	41
Section K. PLANNED ACTIVITIES TO IMPROVE SAFETY.....	42
Section M. ANNEXES.....	43

## **List of Abbreviations**

BDS	Borehole Disposal System
CRWMF	Centralised Radioactive Waste Management Facility
CRWPU	Centralised Radioactive Waste Processing Unit
CRWSU	Centralised Radioactive Waste Storage Unit
DSRS	Disused sealed radioactive sources
GAEC	Ghana Atomic Energy Commission
GHARR-1	Ghana Research Reactor-1
HEU	Highly Enriched Uranium
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiation Protection
LEU	Low Enriched Uranium
NADMO	National Disaster Management Organisation
NORM	Naturally Occurring Radioactive Materials
NRA	Nuclear Regulatory Authority
PCSA	Post-Closure Radiological Safety Assessment
RWMC	Radioactive Waste Management Centre
SNAS	School of Nuclear and Allied Sciences
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation

## Section A. Introduction

### A.1.0 Background

The Republic of Ghana recognising the importance of the safe management of spent nuclear fuel and radioactive waste, acceded to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (Joint Convention) in May 2011, and Her obligations under the Convention entered into force in July 2011 with the objective of achieving and maintaining a high level of safety in spent fuel and radioactive waste management. Each Member State having ratified the Joint Convention (Contracting Party) is obligated to prepare a National Report covering the scope of the Joint Convention and subject it to review by other Contracting Parties at Review Meetings held in Vienna, Austria. Since the Joint Convention entered into force, there have been six (6) Review Meetings held at the IAEA Headquarters in Vienna.

The first Ghana National Report was presented at the Fourth Review Meeting of the Contracting Parties of the Joint Convention in May 2012. Ghana has thus participated in all the Review Meetings since the Fourth Review Meeting of the Joint Convention.

Peaceful utilization of radioactive materials in Ghana began over six decades ago. The radioactive materials are being used for diagnostic and therapeutic procedures in medicine, sterilization of medical products, industrial radiography, nuclear gauging in the mining, road construction, exploration, manufacturing, and petrochemical industries. Food irradiation for shelf life extension, preservation and disinfestations are among the applications of radiation sources in Ghana. Radiation sources are also being employed for research activities in institutions of higher learning. Ghana operates a 34-kW tank-in-pool research reactor, Ghana Research Reactor-1 (GHARR-1). It is a Miniature Neutron Source Reactor mainly used for neutron activation analysis. It originally used High Enriched Uranium (HEU) as fuel which has been converted to Low Enriched Uranium (LEU). All these practices generate radioactive waste.

Placing priority on the safety of human health and the protection of the environment from hazards associated with radioactive waste, the Government of Ghana has put in place legislation that provides the basis for a comprehensive regulatory regime. The Nuclear Regulatory Authority Act of 2015 (**Act 895**), which came into force in August 2015 and repealed the Radiation Protection Instrument of 1993 (LI 1559), is the key legislation that ensures the safety of the nuclear industry and radioactive waste management in Ghana. **Act 895** established the Nuclear Regulatory Authority (NRA) with the objectives to ensure that radiation and nuclear energy are used by authorised persons and only for peaceful purposes, to provide for the protection of persons and the environment against the harmful effects of radiation hazards and to pursue and ensure strict compliance with the provisions of the **Act 895**. The primary responsibility for the management of radioactive wastes, spent fuel inclusive, lies with the generator of the waste. The State supervision of radiation safety on spent fuel and radioactive waste management is performed by the NRA.

For human resource development, the School of Nuclear and Allied Sciences (SNAS) was jointly established by the Ghana Atomic Energy Commission (GAEC) and the University of Ghana (UG), in co-operation with the International Atomic Energy Agency (IAEA), in 2006. The School currently has five academic departments that offer twelve accredited Master of Philosophy (M.Phil.) and Doctor of Philosophy (PhD) programmes. The School was designated as AFRA/IAEA Regional Centre of Excellence for Professional and Higher Education in Nuclear Science and Technology in September 2009, Radiation Protection in October 2011 and Medical Physics in September 2014. The School in collaboration with the IAEA also runs PhD “sandwich” programmes. This ensures adequate human resource development not only for safe management of radioactive waste, but also a broad human resource base for peaceful application of nuclear technology in Ghana and Africa.

The Phase 1 follow-up Integrated Nuclear Infrastructure Review (INIR) Mission was held from 21–24 October 2019 in Accra, Ghana. The follow-up INIR team concluded that Ghana has completed the studies needed for the government of Ghana to make a knowledgeable commitment to a nuclear power programme. Ghana has also completed its assessment of the adequacy of its national legal framework and has made plans to proceed with the necessary amendments.

### **A.1.1 Provisions of the Joint Convention**

The Joint Convention is the first international instrument that deals with the safety of spent fuel management and safety of radioactive waste management in States with and without nuclear programmes. It was adopted on 5 September 1997 at a Diplomatic Conference convened by the IAEA at its headquarters from 1-5 September 1997. It was opened for signature at the IAEA General Conference on 29 September 1997. Pursuant to Article 40, the Joint Convention entered into force on 18 June 2001, 90 days after the date of deposit with the IAEA.

The Joint Convention is aimed at achieving and maintaining a high level of safety in spent fuel and radioactive waste management, ensuring that there are effective defences against potential hazards during all stages of management of such materials, and preventing accidents with radiological consequences. The Joint Convention covers the safety of spent fuel and radioactive waste management from civilian applications. This also applies to the management of military or defence-originated spent fuel and radioactive waste, if and when such materials are transferred permanently to, and managed within exclusively civilian programmes. The Joint Convention calls on the contracting parties to review safety requirements and conduct environmental assessments both at existing and proposed spent fuel and radioactive waste management facilities. It provides for the establishment and maintenance of a legislative and regulatory framework to govern the safety of spent fuel and radioactive waste management.

The Joint Convention establishes rules and conditions for the transboundary movement of spent fuel and radioactive waste that, inter alia, requires the State of destination to have adequate administrative and technical capacity and a regulatory infrastructure to manage spent fuel or radioactive waste in a manner consistent with the Joint Convention. It obligates a State of origin

to take appropriate steps to permit re-entry into its territory of such material if a transboundary movement cannot be completed in conformity with the Joint Convention.

### **A.2.0 Purpose of this Report**

This report is the Fourth National Report under the Joint Convention. It's an update of the previous National Reports, prepared in 2011, 2014 and 2017, and documents the safe and secure management of spent nuclear and radioactive waste in the Republic of Ghana and demonstrates how Ghana continues to fulfil its obligations under the Joint Convention. It also incorporates responses to comments and issues raised at the Sixth (6<sup>th</sup>) Review Meeting of the Contracting Parties.

### **A.2.1 Structure of this Report**

This report is structured according to the “guidelines regarding national reports” for the Joint Convention – i.e., an “article-by-article” format, with each one being addressed in a dedicated chapter bearing the corresponding text of the relevant article of the Joint Convention in italics at the top of the chapter. After the Introduction (Section A), the various sections deal successively with the following topics in the specific order prescribed by the guidelines:

- Section B: Policy and practices under the Joint Convention (Article 32-1);
- Section C: Scope (Article 3);
- Section D: Spent-fuel and radioactive-waste Inventories (Article 32-2);
- Section E: Legislative and regulatory system in force (Articles 18 to 20);
- Section F: Other general safety provisions (Articles 21 to 26);
- Section G: The safety of spent-fuel management (Articles 4 to 10);
- Section H: The safety of radioactive-waste management (Articles 11 to 17);
- Section I: Transboundary movements (Article 27);
- Section J: Disused sealed sources (Article 28),
- Section K: Planned safety-improvement actions; and
- Section L: Annexes in support of Section D.



### **A.3.0 Issues Arising from the 6<sup>th</sup> Review Meeting**

Planned measures to improve safety identified by the Contracting Parties at the 6<sup>th</sup> Review Meeting to be addressed.

- Development of the waste management policy and strategy to cover the envisaged future use of nuclear power

The draft National Radioactive Waste Management Policy and Strategy developed in 2014 with assistance from the IAEA under the Technical Cooperation Project INT9176: Strengthening Cradle-to-Grave Control of Radioactive Sources in the Mediterranean Region had to undergo revision in 2018. The revision was led by the Nuclear Regulatory Authority. The revised draft Policy and Strategy document has been completed and submitted to the relevant stakeholders for comments. Comments from stakeholders will be incorporated in the document for approval by the Sector Minister.

- Development of Regulations to give effect to the Nuclear Regulatory Authority Act of 2015 (Act 895)

The Draft Basic Ionising Radiation Control Regulations and Draft Safeguards Regulations have been forwarded by the Board of NRA to the Office of the Attorney-General and Ministry of Justice for onward submission to Parliament for approval. The Draft Radioactive Waste Management Regulations has been sent for stakeholder review. Further improvements in development of regulations and guidelines are reported in Section E2.2.1.

- Provision of adequate resources for timely implementation of the Borehole Disposal System (Waste Management Fund)

The Government of Ghana has committed to provide funds for implementation of the Borehole System. The draft National Radioactive Waste Management Policy and Strategy calls for the establishment of a National Radioactive Waste Management Fund that will ensure that there will be sufficient provisions for implementation of the Borehole Disposal System as well as the long-time management of other types of radioactive waste.

- Review and Assessment of Safety Case for Disposal System

The Operator (GAEC) developed a Draft Safety Case document for the Implementation of the Borehole Disposal System in Ghana which was reviewed by a team of experts during a consultative meeting held at the IAEA headquarters in Vienna in May 2019. One of the main recommendations after the Review a change in the conceptual design to address the site characteristics. The safety case documentation is being updated with the expert's recommendation.

## **Section B. Policies and Practices**

### **B.1 Article 32.1: Reporting**

*In accordance with the provisions of Article 30, each Contracting Party shall submit a national report to each review meeting of Contracting Parties. This report shall address the measures taken to implement each of the obligations of the Convention. For each Contracting Party the report shall also address its:*

- (i) spent fuel management policy;*
- (ii) spent fuel management practices;*
- (iii) radioactive waste management policy;*
- (iv) radioactive waste management practices;*
- (v) criteria used to define and categorize radioactive waste.*

#### **B.1.1 Radioactive Waste Management Policy Framework**

As a Member State of the International Atomic Energy Agency (IAEA), and in accordance with National and International law, the Ghanaian Government's policy on radioactive waste management is to deal with radioactive waste in a manner that protects human health and the environment both now and in the future without imposing undue burden on the future generation.

The Draft National Radioactive Waste Management Policy and Strategy document, when approved, will serve as a national commitment to address radioactive waste management in Ghana, in a coordinated and cooperative manner.

The first draft of the National Radioactive Waste Management Policy and Strategy developed in 2014 with assistance from the IAEA under the Technical Cooperation Project INT9176: Strengthening Cradle-to-Grave Control of Radioactive Sources in the Mediterranean Region had to undergo revision in 2018. The revision was led by the NRA. The revision of the draft Policy and Strategy document to address spent fuel management was completed in June 2020 and has been submitted to the relevant stakeholders for comments. Comments from stakeholders will be incorporated in the document for approval by the Sector Minister.

The draft National Policy and Strategy is to ensure the safe, secure and sustainable management of spent fuel and radioactive waste in the Republic of Ghana. The policy is consistent with the requirements of the national legislative system, relevant international principles, and all international agreements to which the Republic of Ghana is signatory.

The draft Policy and Strategy outlines the main policy principles that the Republic of Ghana will endeavour to implement, in order to achieve the overall policy objectives. The draft Policy and Strategy defines the roles and responsibilities of the organizations and bodies concerned with spent fuel and radioactive waste management in the Republic of Ghana. It furthermore provides for openness and transparency in spent fuel and radioactive waste management through the supply of public information and the involvement of public and stakeholders in the decision-making process to the extent that this is commensurate with security. It also provides

for the development of institutional and financial arrangements to implement long-term waste management solutions in a safe, environmentally sound, comprehensive, cost-effective and integrated manner.

The scope of the Policy and Strategy relates to the safe and secure management of all forms of radioactive wastes, except operational radioactive liquid and gaseous effluent (waste discharges), which is permitted to be released to the environment routinely with the approval of the NRA and other relevant regulatory bodies. It also includes the management of spent fuel arising from nuclear installations.

Waste containing naturally occurring radioactive materials (NORM), which may arise from the extraction and processing of oil, gas and minerals, falls within the remit of this policy if it exceeds exemption levels as provided for in the draft Basic Ionizing Radiation Control Regulations.

The draft Policy and Strategy also calls for the establishment of a National Radioactive Waste Management Fund that will ensure that there will be sufficient provisions for the safe management of radioactive waste. The Fund to be established shall be managed by the Nuclear Regulatory Authority (NRA).

### **B.1.2 Spent fuel management policy**

For radioactive wastes that will remain hazardous for many years, the Government of Ghana recognizes two long term management options. The first, which is preferred, entails repatriation to the country of origin. This option will be applied, when practicable, to disused sealed radioactive sources (DSRS) and research reactor fuel. The second option is storage followed by permanent disposal in a suitably designed disposal facility. The nature of this disposal and its timing will be decided by the Government having due regard to intergenerational equity i.e. the principle that present-day society has an obligation to deal with the liabilities it creates rather than pass them on to future generations. Any Government Ministry or other body considering the construction of an additional or the replacement of the research reactor on the territory of the Republic of Ghana shall give high priority to establishing a return of spent fuel assembly to the supplier or country of origin.

The Government of the Republic of Ghana has plans to introduce nuclear power into Ghana's energy mix. The draft Policy and Strategy prescribes the domain within which the spent fuel shall be managed.

### **B.2. Radioactive Waste Management Practices**

Within the Ghanaian regulatory framework, radioactive waste, for legal and regulatory purposes, is defined to mean "material, in whatever physical form, remaining from facilities and activities and for which further use is not foreseen that contains or is contaminated with radioactive substances and has an activity or activity concentration higher than the level set for

clearance from regulatory requirements” [Section 93 of the Nuclear Regulatory Act, 2015 (Act 895)]

It should be recognised that this definition is purely for regulatory purposes, and that material with activity concentrations equal to or less than clearance levels is radioactive from a physical viewpoint, although the associated radiological hazards may be negligible.

The general aim in the management of radioactive waste is to reduce, to as low as practicable and justifiable, the associated risks by appropriate management of the waste. The following waste management options are to be followed where practicable in accordance with national regulations, ALARA principle and other international guidance:

- Return to Supplier
- Waste Minimisation
- Interim Storage
- Treatment, Conditioning and Disposal

Disused sealed radioactive sources (DSRS) comprise by far the greater part of the radioactive waste, in terms of both volume and activity, currently in interim storage. The radioactive waste management practice in Ghana entails safe and secure storage. The NRA has established a national register of radiation sources as well as an inventory of radioactive waste. The Radioactive Waste Management Centre (RWMC) is also required to maintain an up-to-date inventory of radioactive waste. The NRA requires licensees during the authorisation process to give priority to returning their disused sealed radioactive sources, especially category 1 and 2 sealed radioactive sources, to the respective supplier countries.

It is accepted that, for those solid radioactive wastes that are not repatriated or decay stored to exemption/ clearance levels, long-term safety and security can only be achieved by permanent disposal in a suitably authorized facility. GAEC will evaluate technical options for disposal of existing and anticipated DSRSs in the Republic of Ghana.

Liquid and gaseous wastes may be discharged to the environment upon meeting all the required regulatory requirement that ensures protection of human health and environment.

Radioactive wastes generated in Ghana are categorised as follows:

- Controlled wastes: - These are radioactive wastes that arise out of facilities and activities duly authorised by the NRA.
- Legacy wastes: - these are wastes generated from known sources and practices, but the owners no longer have the capability to manage the wastes due to bankruptcy or other reasons. Most of the legacy sources are those that predated the establishment of regulatory regime.
- Orphan wastes: - these are wastes arising from facilities and activities whose owners could not be traced. They include stolen or lost sources that are recovered. The handling of these wastes is like those of the legacy wastes

- NORMs: - These are wastes associated with activities related to the oil and gas industries with radioactivity above exemption levels. Research work is being carried out to determine the particular hazards associated with this category and the means to handle them.

The classification of radioactive wastes is based on the activity concentration and half-lives of radionuclides as provided in the IAEA GSG-1 (2009), as follows:

(i) Exempt waste (EW): Waste that meets the criteria for clearance, exemption or exclusion from regulatory control for radiation protection purposes

(ii) Very short-lived waste (VSLW): Waste that can be stored for decay over a limited period of up to a few years and subsequently cleared from regulatory control according to arrangements approved by the NRA, for uncontrolled disposal, use or discharge. This class includes waste containing primarily radionuclides with very short half-lives often used for research and medical purposes.

(iii) Very low-level waste (VLLW): Waste that does not necessarily meet the criteria of EW, but that does not need a high level of containment and isolation and, therefore, is suitable for disposal in near surface landfill type facilities with limited regulatory control. Such landfill type facilities may also contain other hazardous waste. Typical waste in this class includes soil and rubble with low levels of activity concentration. Concentrations of long-lived radionuclides in VLLW are generally very limited.

(iv) Low level waste (LLW): Waste that is above clearance levels, but with limited amounts of long-lived radionuclides. Such waste requires robust isolation and containment for periods of up to a few hundred years and is suitable for disposal in engineered near surface facilities. This class covers a very broad range of waste. LLW may include short lived radionuclides at higher levels of activity concentration, and also long-lived radionuclides, but only at relatively low levels of activity concentration.

(v) Intermediate level waste (ILW): Waste that, because of its content, particularly of long-lived radionuclides, requires a greater degree of containment and isolation than that provided by near surface disposal. However, ILW needs no provision, or only limited provision, for heat dissipation during its storage and disposal. ILW may contain long lived radionuclides, in particular, alpha emitting radionuclides that will not decay to a level of activity concentration acceptable for near surface disposal during the time for which institutional controls can be relied upon. Therefore, waste in this class requires disposal at greater depths, of the order of tens of metres to a few hundred metres.

(vi) High level waste (HLW): Waste with levels of activity concentration high enough to generate significant quantities of heat by the radioactive decay process or waste with large amounts of long-lived radionuclides that need to be considered in the design of a disposal facility for such waste. Disposal in deep, stable geological formations usually several hundred metres.

## **Section C. Scope of Application**

### **C.1: Article 3. Scope of Application**

*1. This Convention shall apply to the safety of spent fuel management when the spent fuel results from the operation of civilian nuclear reactors. Spent fuel held at reprocessing facilities as part of a reprocessing activity is not covered in the scope of this Convention unless the Contracting Party declares reprocessing to be part of spent fuel management.*

*2. This Convention shall also apply to the safety of radioactive waste management when the radioactive waste results from civilian applications. However, this Convention shall not apply to waste that contains only naturally occurring radioactive materials and that does not originate from the nuclear fuel cycle, unless it constitutes a disused sealed source or it is declared as radioactive waste for the purposes of this Convention by the Contracting Party.*

*3. This Convention shall not apply to the safety of management of spent fuel or radioactive waste within military or defence programmes, unless declared as spent fuel or radioactive waste for the purposes of this Convention by the Contracting Party. However, this Convention shall apply to the safety of management of spent fuel and radioactive waste from military or defence programmes if and when such materials are transferred permanently to and managed within exclusively civilian programmes.*

This report does not consider reprocessing of spent fuel as no reprocessing plant exists in Ghana. The spent fuel referred to in this report will be generated from civilian application only. No form of radioactive waste of military origin exists in Ghana; therefore, this report does not discuss this type of waste.

## Section D. Inventories and Lists

### Article 32. Reporting,

*This report shall also include:*

- (i) a list of the spent fuel management facilities subject to this Convention, their location, main purpose and essential features;*
- (ii) an inventory of spent fuel that is subject to this Convention and that is being held in storage and of that which has been disposed of. This inventory shall contain a description of the material and, if available, give information on its mass and its total activity;*
- (iii) a list of the radioactive waste management facilities subject to this Convention, their location, main purpose and essential features;*
- (iv) an inventory of radioactive waste that is subject to this Convention that:
  - (a) is being held in storage at radioactive waste management and nuclear fuel cycle facilities;*
  - (b) has been disposed of; or*
  - (c) has resulted from past practices. This inventory shall contain a description of the material and other appropriate information available, such as volume or mass, activity and specific radionuclides;**
- (v) a list of nuclear facilities in the process of being decommissioned and the status of decommissioning activities at those facilities.*

### D.3 Radioactive Waste Management Facilities

The Radioactive Waste Management Centre (RWMC) of GAEC operates a Centralised Radioactive Waste Management Facility (CRWMF) for safe and secure management of radioactive waste. It comprises of a Centralised Radioactive Waste Storage Unit (CRWSU) and a Centralised Radioactive Waste Processing Unit (CRWPU). At the CRWPU, waste materials will be processed (pre-treatment, treatment and conditioning) while the CRWSU is for the storage of both processed and unprocessed radioactive waste materials. The CRWPU is currently being refurbished, however the conditioning room is near completion and is currently being utilised for consolidation of category 3-5 disused sealed radioactive sources (DSRS).

The CRWSU has a large holding area for the receipt and characterization of radioactive waste materials and two storage rooms for storage of high radioactivity waste pending disposal and low activity short-lived waste pending decay for clearance. With the assistance of the United States Department of Energy's National Nuclear Security Administration (NNSA), office of Global Threat Reduction Initiative (GTRI), the CRWMF has been equipped with physical protection equipment such as CCTV cameras and access control system.



**Figure 1a: Front view of the Centralised Radioactive Waste Processing Unit**



**Figure 1b: Front view of the Centralised Radioactive Waste Storage Unit**



#### **D.4 Inventory of Radioactive Waste**

The RWMC has developed a Microsoft excel database for radioactive waste materials it is managing. The inventory of radioactive waste in the storage facility is given in **Annex V**.

## Section E. Legislative and Regulatory System

### E.1 Implementing Measures

#### *Article 18: Implementing Measures*

*Each Contracting Party shall take, within the framework of its national law, the legislative, regulatory and administrative measures and other steps necessary for implementing its obligations under this Convention.*

In conformance to Article 18 of the Joint Convention, the Republic of Ghana has undertaken the necessary legislative, regulatory and administrative measures to fulfil its obligations under the Joint Convention and these are reported in this report.

### E.2 Legislative and Regulatory Framework

#### *Article 19: Legislative and Regulatory Framework*

- 1. Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of spent fuel and radioactive waste management.*
- 2. This legislative and regulatory framework shall provide for:*
  - (i) the establishment of applicable national safety requirements and regulations for radiation safety;*
  - (ii) a system of licensing of spent fuel and radioactive waste management activities;*
  - (iii) system of prohibition of the operation of a spent fuel or radioactive waste management facility without a licence;*
  - (iv) a system of appropriate institutional control, regulatory inspection and documentation and reporting;*
  - (v) the enforcement of applicable regulations and of the terms of the licences;*
  - (vi) a clear allocation of responsibilities of the bodies involved in the different steps of spent fuel and of radioactive waste management.*
- 3. When considering whether to regulate radioactive materials as radioactive waste, Contracting Parties shall take due account of the objectives of this Convention*

In terms of the legislative framework, the Nuclear Regulatory Authority Act, 2015 (Act 895) has provided the general framework for control and use of radiological and nuclear materials in Ghana. Specifically, section 38 (g) of the Act requires for arrangements for the management of radioactive waste and decommissioning during the preconstruction review and assessment of nuclear installations. In addition, section 44 (c), (d) and (f) has provisions for the management of radioactive waste including spent fuel management.

Radioactive waste management practice is also subjected to the provisions of other relevant legislations, regulations and guidelines as follows:

- Local Governance Act, 2016 (Act 936)

- Atomic Energy Commission Act, 2000 (Act 588)
- Environmental Protection Agency Act, 1994 (Act 490),
- Environmental Assessment Regulations of 1999 (LI 1652),
- Environmental Sanitation Policy of Ghana (1999),
- Guidelines for the Development and Management of Landfills in Ghana, and
- Guidelines for Bio-medical Waste (2000).

## **E.2.2. Regulatory Framework**

### **E.2.2.1. Safety Requirements and Regulations for Radiation Safety**

From 1993 to 2015 the Ghana Atomic Energy Commission (GAEC) pursuant to the Legislative Instrument LI 1559 of 1993 was responsible for enforcing radiation safety requirements for the possession and use of radiation in Ghana. In 2015, the Nuclear Regulatory Authority, 2015 (Act 895), was promulgated by the Government of Ghana to establish and maintain a comprehensive legislative and regulatory framework to among other things govern the safety of nuclear and radiological installations, provide for a system of licensing, regulatory inspection and assessment of nuclear and radiological installations and to ascertain compliance and enforcement of safety requirements.

Ghana has been a member of the IAEA since September 1960 and a party to the following International Legal Instruments:

- Convention on Early Notification of a Nuclear Accident;
  - Convention on Assistance in the Case of Nuclear Accident or Radiological Emergency
  - Convention on Nuclear Safety;
  - Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (the Joint Convention);
  - Convention on Physical Protection of Nuclear Material and Amendment thereto;
  - Convention on Supplementary Compensation for Nuclear Damage (CSC);
  - Vienna Convention on Civil Liability for Nuclear Damage;
  - Protocol to Amend the Vienna Convention on Civil Liability for Nuclear Damage;
  - Joint Protocol Relating to the Application of the Vienna Convention and of the Paris Convention.
  - Comprehensive Safeguards Agreement in connection with the Treaty on Non-Proliferation of Nuclear Weapons;
  - Additional Protocol to the Agreement on Safeguards in connection with the Treaty on Non-Proliferation of Nuclear Weapons;
  - Revised Supplementary Agreement Concerning the Provision of Technical Assistance by the IAEA
- 
- the Comprehensive Nuclear Test Ban Treaty (CBTB);
  - the African Nuclear Weapon Free Zone Treaty (Pelindaba);

## **National Regulations and Guidelines**

The NRA initiated the development of the relevant regulations and Guides since its establishment in 2016 to complement the implementation of the provisions of Nuclear Regulatory Authority Act, 2015 (Act 895). The following regulations and associated guidelines are under development:

- Radioactive waste management regulations
- Basic Ionising Radiation Control Regulations
- Safeguards Regulations
- Site Evaluation of Nuclear Installations Regulations
- Licensing of Nuclear Installations Regulations
- Emergency Preparedness and Response Regulations
- Nuclear Security Regulations
- Nuclear Liability Regulations
- Requirements for Technical Support Services.
- Management System Regulations
- Design of Nuclear Installation regulations
- Decommissioning of Nuclear Installation regulations
- Construction of a Nuclear Installation Regulations
- Guidance on Radiation Protection Programme of a Nuclear Installation
- Periodic Testing, Maintenance, Inspection and Control of Modifications and Surveillance of a Nuclear Installation Regulations
- Guidance on Operational Limits and Conditions of a Nuclear Installation
- Commissioning of a Nuclear Installation regulations
- Guidance on Education, Training, Qualification and Certification of Personnel of a Nuclear Installation
- Guidance for Development of Safety Case for Borehole Disposal Facility
- Establishing and Operating a Training Institution for Personnel of a Nuclear Installation

### **E.2.2.2. Licensing of Activities**

The Nuclear Regulatory Authority Act, 2015 (Act 895) has provisions that requires that all activities or the operation of a facility that might give rise to radiation exposure are duly authorized. Sections 21 and 23 specifically require the authorization of all facilities and activities and the obligations of the authorized persons respectively.

An application for a license shall be made to the NRA using an application form of the NRA, detailing the intended activities and providing a demonstration of the safety and compliance to the requirements as provided for in the Act and the regulations. Any person or organization applying for an authorization shall:

- (a) Submit to the NRA relevant information necessary to support the application, including:
- (i) An evaluation of the nature, likelihood and magnitude of the exposures associated with the activities;
  - (ii) A safety and security case including relevant safety, security and environmental assessments;
  - (iii) An emergency preparedness and response plan;
  - (iv) a proposed arrangement for the management of radioactive waste, spent nuclear fuel or disused sealed radiation source generated;
  - (v) a proposed system for record keeping;
  - (vi) Reporting;
  - (vii) proposal for discharge and environmental monitoring; and
  - (viii) any other details the NRA may consider necessary for the purpose of authorisation.
- (b) Ensure the availability of human and financial resources to complete the waste management and disposal activities satisfactorily, including disposal borehole closure and the decommissioning of any associated surface facilities.

Following the receipt of an application for authorization or permit, the application is reviewed and assessed against the regulatory requirements to ensure that the operation of the facility or activity to be carried out meet the regulatory requirements.

From the review assessment, inspection to verify information and data provided in the application is carried out for the issuance of authorization certificate (license) for the facility or activity and the conditions of the authorization. The authorisation conditions represent a framework within which the applicant or holder of the license is obliged to adhere to particular requirements in respect of design, operation, maintenance, decommissioning and closure. The conditions of authorisation also oblige the holder of the license to provide a demonstration of compliance through the submission of routine and non-routine reports.

### **E.2.2.3. Prohibition of the Operation without an Authorisation**

Section 21 of the Nuclear Regulatory Authority Act, 2015 (Act 895) prohibits an applicant to engage in an activity or a practice which involves the use of nuclear material or any radiation source, unless that person is authorized by the NRA.

Section 43 (1) also prohibits a person or entity to operate a radioactive waste management facility, unless the person or entity is authorised by the NRA.

#### **E.2.2.4. Regulatory Inspections, Safety Documentation and Reporting**

The authorisation process requires the applicant for the purpose of the safe management of radioactive waste, spent fuel or disused sealed radiation sources to carry out safety assessment and develop and maintain a safety case to demonstrate that the facility and all activities will be carried out safely. The safety case should demonstrate that at all stages of the lifetime of the facility from site selection and evaluation, the design, construction, operation, decommissioning, closure and, if necessary, post closure surveillance activities of the facilities are in accordance with national strategy and in compliance with national regulations to ensure the safety of workers, the environment and the general public.

The safety case and supporting safety assessment shall be prepared and updated by the operator, at each step in the development, operation and closure of a facility for the management of radioactive waste, spent nuclear fuel or disused sealed radiation sources and periodically during operation as required by the NRA. The operator shall submit the safety case to the NRA for review and assessment and approval.

The safety case shall describe all the safety relevant aspects of the site, the design of the facility, and the managerial and regulatory controls. The safety case and supporting safety assessment shall demonstrate the level of protection and safety provided and shall provide assurance of safety at all stages.

Measures shall be implemented by the operator to ensure an integrated approach to safety, nuclear security and if applicable nuclear safeguards in the management and disposal of radioactive waste, spent nuclear fuel and disused sealed radiation sources. The level and complexity of safety and security provisions shall be commensurate with the degree of hazard posed by the radioactive waste, spent nuclear fuel or disused sealed radiation sources to be managed.

Management systems to provide for assurance of quality shall be applied by the operator to all safety related activities, systems and components throughout all the steps of the development and operation of a radioactive waste, spent nuclear fuel or disused sealed radiation source management or disposal facility. The level of assurance for each element shall be commensurate with its importance to safety. Operators shall take into account the interdependences among all steps in the predisposal management of radioactive waste, spent nuclear fuel and disused sealed radiation sources as well as the impact of the anticipated disposal option.

Operators shall determine an authorized destination for all radioactive waste, spent nuclear fuel and disused sealed radiation sources generated in consultation with RWMC and authorized by NRA.

Operators shall make adequate provision for the training of personnel in radiation protection and safety.

Operators shall keep a system for recording information on the generation, characteristics, processing, storage, transportation and disposal of the waste, spent nuclear fuel and disused sealed radiation sources.

#### **E.2.2.5. Enforcement**

A person who fails to comply with the provisions of Nuclear Regulatory Authority Act, 2015 (Act 895), or does anything contrary to the provisions of the Act commits an offence and is liable on summary conviction to a fine or imprisonment or both, as prescribed in section 80 of the Act.

### **E.3 The Establishment of a Regulatory Body**

#### ***Article 20: Regulatory Body***

*1. Each Contracting Party shall establish or designate a regulatory body entrusted with the implementation of the legislative and regulatory framework referred to in Article 19, and provided with adequate authority, competence and financial and human resources to fulfil its assigned responsibilities.*

*2. Each Contracting Party, in accordance with its legislative and regulatory framework, shall take the appropriate steps to ensure the effective independence of the regulatory functions from other functions where organizations are involved in both spent fuel or radioactive waste management and in their regulation.*

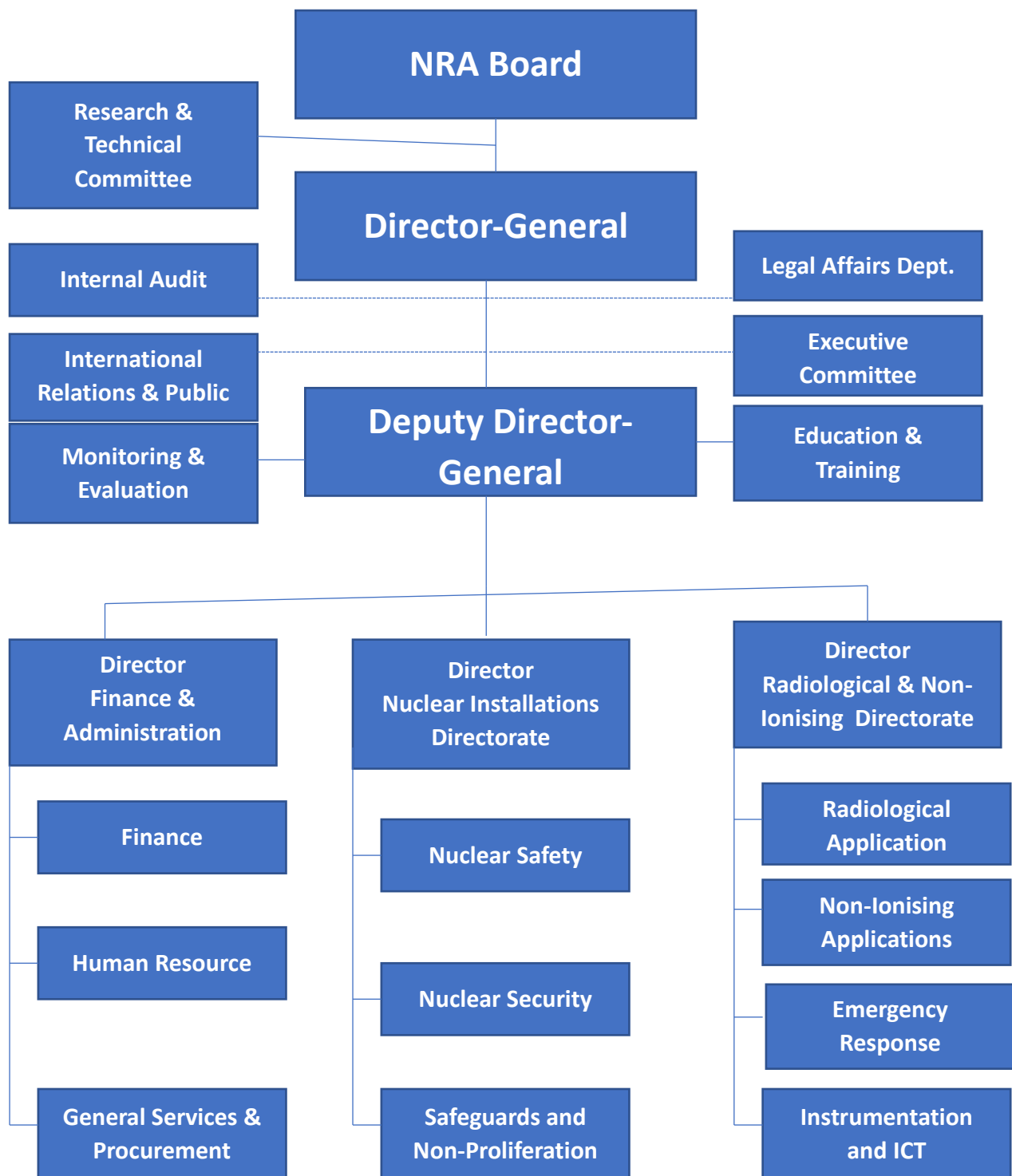
#### **E.3.1. Nuclear Regulatory Authority (NRA)**

The Nuclear Regulatory Authority (NRA) was established with the enacted by Parliament of Ghana, the Nuclear Regulatory Authority Act, 2015 (Act 895), as the effectively independent regulatory body with the statutory function to regulate and provide for the peaceful use of nuclear material or energy, radioactive material or radiation to provide for the protection of persons and the environment against the harmful effects of radiation hazards.

The establishment, objectives, functions and powers of the authority are provided for in sections 3, 4, 5 and 6 of the Act.

#### **E.3.2. Organisational Structure of Nuclear Regulatory Authority**

The governing body of the Nuclear Regulatory Authority (NRA) known as the NRA Board consists of a chairperson and six other members including the Director-General of the NRA. The Members of the Board are appointed by the President. Figure 2 below shows the organizational structure of the NRA, Ghana. The function of the NRA Board is to initiate policies for the development of the NRA; ensure the proper management of resources of the NRA and ensure the implementation of the functions as provided for by the Nuclear Regulatory Authority Act, 2015 (Act 895) and any other relevant enactments. The Board of the NRA meets once every three months.



**Figure. 2: Organisational structure of the Nuclear Regulatory Authority**

To complement the work of the Board, a Technical Committee of the Board has been formed and is responsible for reviewing all Technical Documents and provide advice to the Board for approval of such documents. The Technical Committee is also responsible for reviewing and recommending for approval by the Board of reports to be sent to the International Atomic Energy Agency, including reports on Ghana's obligations under the Joint Convention,

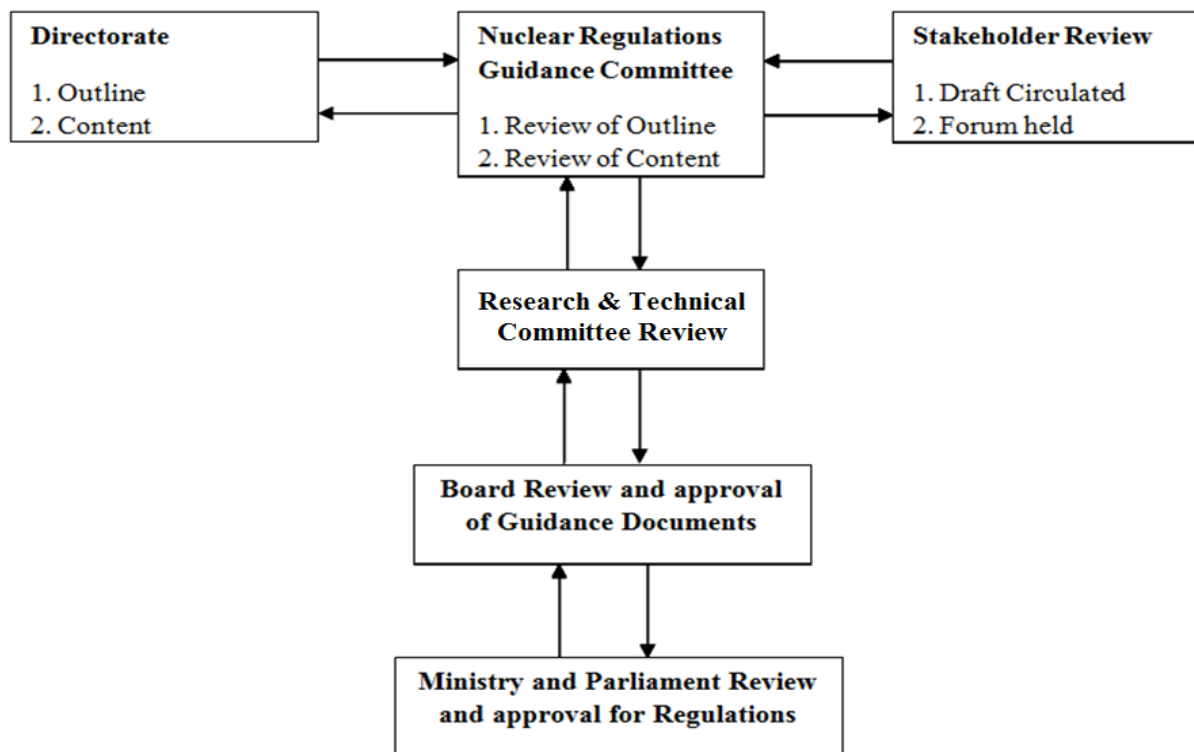


Convention on Nuclear Safety, among others. The Committee holds quarterly meetings in order to discharge all of its duties.

The Director-General is appointed by the President in accordance with article 195 of the Constitution of the Republic of Ghana and is also a member of the Board. The Director-General is accountable to the Board of the NRA and has the primary responsibility to ensure that the functions of the NRA are performed in accordance with provisions of Act 895 and supporting Regulations.

The Deputy Director-General is appointed on the recommendation of the Board and in accordance with article 195 of the Republic of Ghana Constitution by the President. The Deputy Director General assists the Director-General in the administration of the NRA.

The Executive Committee assists the Director-General in the day to day administration of the affairs of the NRA, recommends guidelines, procedures and other related matters of the NRA for review by the Technical Committee, recommends the licensing and certification requirements for technical support services and consultancies, recommends for approval reports to be sent to the International Atomic Energy Agency, including reports on Ghana's obligations under the Joint Convention, Convention on Nuclear Safety, among others. The Committee holds regular meetings in order to discharge all of its duties.



**Figure 3: Process for Review and Approval of Regulations**

Pursuant to Act 895, NRA has established three Directorates and ten Departments for the necessary operation of the Authority as shown in Figure 2. Regulations are drafted at the Directorates or by an Inter-Directorate Committee, followed by review from Nuclear Regulations Guidance Committee, Research & Technical Committee and the Board. Stakeholders are consulted and involved in the development of the regulations through Workshops, Public Meetings and involvement in Committees (Figure 3).

## Section F. General Safety Provisions

### F.1 Responsibility of the Licence Holder

#### *Article 21: Responsibility of the Licence Holder*

- 1. Each Contracting Party shall ensure that prime responsibility for the safety of spent fuel or radioactive waste management rests with the holder of the relevant licence and shall take the appropriate steps to ensure that each such licence holder meets its responsibility.*
- 2. If there is no such licence holder or other responsible party, the responsibility rests with the Contracting Party, which has jurisdiction over the spent fuel or over the radioactive waste*

In accordance with the provisions of Nuclear Regulatory Authority Act, 2015 (Act 895) and the National Radioactive Waste Management Policy, the prime responsibility for ensuring protection of the health and safety of the workers and members of the public as well as protection of the environment rests with the authorised person. This responsibility includes providing adequate human and financial resources to support the safe management of the spent fuel and radioactive waste as well as waste management facility over its lifespan.

Ghana has a draft Radioactive Waste Management Regulations currently undergoing review for adoption. The Regulations cover the requirements associated with steps such as; the collection, segregation, characterisation, treatment, conditioning, storage, disposal and preparation for transport of radioactive waste arising from medical, industrial and research facilities where radioactive materials and sources of ionising radiation are produced, used or handled. The Regulations relate to all radioactive wastes, including operational radioactive liquid and gaseous effluent (waste discharges), which are permitted to be released to the environment routinely under the authority of the NRA.

The Regulations apply to all sources of ionising radiation used in the medical, teaching and research, agriculture, hydrology, geological industries and other fields of human activity where the waste generated as a result of such activity or practice is subject to registration or licensing.

The Regulations are also based on separation of responsibilities between the waste generator, waste management organization (RWMC) and the Regulatory Body (NRA) as follows:

- (a) any person who generates radioactive waste shall have the prime responsibility for its safe management and shall take the necessary actions to ensure its safety unless such responsibility has been transferred to another person or organisation with the approval of the NRA;
- (b) the NRA is responsible for the enforcement of, and compliance with the provisions of the radioactive waste management regulations;
- (c) any person who generates radioactive wastes shall be responsible for the on-site segregation, collection, characterisation, and temporary storage of that waste

arising from his/her activities and discharge of the exempt waste. The NRA shall be notified by the person who generated the waste in writing of all radioactive wastes that are not expected to decay to clearance levels within one year from the time of their generation;

- (d) no person or organisation shall dispose of any radioactive waste unless the disposal facility designed and constructed specifically for this purpose is available and licensed by the NRA.

Transportation of the radioactive waste from the waste generation site shall be done in accordance with the Transport Regulations and in conformity with the IAEA Safety Standards for the Safe Transport of Radioactive Materials. The RWMC shall notify the NRA in writing of the transfer of the sources to the RWMC.

## **F.2 Human and Financial Resources**

### **Article 22: Human and Financial Resources**

*Each Contracting Party shall take the appropriate steps to ensure that:*

*(i) qualified staff are available as needed for safety-related activities during the operating lifetime of a spent fuel and a radioactive waste management facility;*

*(ii) adequate financial resources are available to support the safety of facilities for spent fuel and radioactive waste management during their operating lifetime and for decommissioning;*

*(iii) financial provision is made which will enable the appropriate institutional controls and monitoring arrangements to be continued for the period deemed necessary following the closure of a disposal facility.*

The authorised person is responsible for human resource planning to fulfil corporate responsibilities. The authorised person has the responsibility for ensuring that the employees are qualified and authorised to undertake their jobs. The authorised person is required to report to the NRA on their staffing and competency levels. The authorised person's employee training programmes shall include initial and refresher training programmes.

The Staff of the NRA and the RWMC have been trained on matters concerning radioactive waste management of all types with assistance from the IAEA. Training and refresher training is envisaged through proposed IAEA training courses as well as national training programmes.

Considering the importance of a well-trained personnel with relevant competencies and skills, Ghana Atomic Energy Commission (GAEC) in collaboration with the University of Ghana and with the support of the IAEA has established the School of Nuclear and Allied Sciences (SNAS). The School runs nuclear-oriented academic programmes which are organised under five departments at the post graduate level. SNAS is an IAEA Regional Designated Centre for professional and higher education in nuclear science and technology, and education and training in radiation protection.

For the purposes of monitoring the GHARR-1 core conversion activities, some staff of the NRA and GAEC received training in security in the transport of radioactive materials, validation of package design certification and safeguards of nuclear materials.

In general, the financing for decommissioning and waste management follows the rule of the “polluter pays” principle. In accordance with this principle all authorised persons are responsible for ensuring that sufficient resources are in place to meet their responsibilities with respect to decommissioning and radioactive waste management.

The RWMC derives the funds for management of the facility from the national budget and from payments made for the management of radioactive waste.

The Nuclear Regulatory Authority Act, 2015 (**Act 895**) stipulates that decommissioning of any radiation source or facility with radioactive materials shall have due regard for the safety of radiological waste in their possession. The authorised person shall assure the NRA of compliance with the following among other things that:

- The authorised person shall ensure that adequate financial resources are available to cover the costs associated with the safe decommissioning, including the management of the resulting waste during the operation of the facility.
- The amount of the financial resources to be made available for decommissioning activities shall be commensurate with the facility’s specific cost estimate and shall be changed if the cost estimate increases or decreases. The cost estimate shall be reviewed as part of the periodic review of the decommissioning plan.

### **F.3: Quality Assurance**

#### ***Article 23: Quality Assurance***

*Each Contracting Party shall take the necessary steps to ensure that appropriate quality assurance programmes concerning the safety of spent fuel and radioactive waste management are established and implemented.*

The Nuclear Regulatory Authority Act, 2015 (**Act 895**) requires the applicant seeking to construct and operate a waste management facility to submit the quality assurance organisation and programme to the NRA for approval. The draft Radioactive Waste Management Regulations places the following requirements for an effective management system on the authorised person:

- The authorised person shall establish a management system that addresses safety, security and safeguards (where applicable) measures and implement the system in an integrated manner during the pre-disposal and disposal management of radioactive waste;
- The authorised person shall demonstrate commitment to protection, safety, security and safeguards (where applicable) at all levels within the organisation;
- The authorised person shall establish a management system, commensurate with the

size and nature of the authorised activity, which ensures that:

- policies and procedures are established that identify safety, security and safeguards (where applicable) as being of the highest priority;
  - problems affecting protection, safety, security and safeguards (where applicable) are promptly identified and corrected in a manner commensurate with their importance;
  - the responsibilities of each individual for safety, security and safeguards (where applicable) and compliance are clearly identified and that each individual is suitably trained and qualified;
  - clear lines of authority for decisions on safety, security and safeguards (where applicable) are defined;
  - organisational arrangements and lines of communications are established that result in an appropriate flow of information on safety and security at and between the various levels in the organisation of the authorised person; and
  - a quality assurance programme is in place for all protection, safety, security and safeguards (where applicable) related activities, systems and components throughout all the steps of pre-disposal and disposal activities of a radioactive waste, spent nuclear fuel or disused sealed radiation sources, which shall provide information on the performance of the waste management programme and equipment, and establishes a regime for review of the programme. This shall ensure that all necessary records are maintained and are readily retrievable when required.
- The authorised person shall ensure that the management system is designed and implemented to enhance protection, safety, security and safeguards (where applicable) by:
    - applying the requirements for protection, safety, security and safeguards (where applicable) coherently with other requirements including requirements for operational performance;
    - describing the planned and systematic actions necessary to provide adequate confidence that the requirements for protection, safety, security and safeguards (where applicable) are fulfilled;
    - ensuring that protection, safety, security and safeguards (where applicable) are not compromised by other requirements;
    - providing for the regular assessment of performance of protection, safety, security, safeguards (where applicable) and the application of lessons learned from experience; and

- promoting safety and security culture.
- The authorised person shall ensure that the protection, safety, security and safeguards (where applicable) elements of the management system are commensurate with the complexity of the radiation risks associated with the activity.
- The management system shall provide:
  - adequate assurance that the established requirements for safety, security, safeguards and environmental protection are being met;
  - arrangements for regular audit and review by independent third parties; and
  - processes to report deficiencies at an appropriate level within the organisation and to initiate remedial actions.

One of the safety requirements of the draft Basic Ionising Radiation Control Regulations is the establishment, implementation and maintenance of a quality management system in order to ensure compliance with the conditions of authorisation for a practice. The quality management systems to provide for assurance of quality shall be applied by the operator to all safety related activities, systems and components throughout all the steps of the development and operation of a radioactive waste, spent nuclear fuel or disused sealed radiation source management or disposal facility. The level of assurance for each element shall be commensurate with its importance to safety. The implementation of a quality management programme is required to provide adequate confidence in the validity of the operational safety assessment and safety assurance processes.

#### **F.4 Operational Radiation Protection**

##### ***Article 24: Operational radiation protection***

1. *Each Contracting Party shall take the appropriate steps to ensure that during the operating lifetime of a spent fuel or radioactive waste management facility:*
  - (i) *the radiation exposure of the workers and the public caused by the facility shall be kept as low as reasonably achievable, economic and social factors being taken into account;*
  - (ii) *no individual shall be exposed, in normal situations, to radiation doses which exceed National prescriptions for dose limitation which have due regard to internationally endorsed standards on radiation protection; and*
  - (iii) *measures are taken to prevent unplanned and uncontrolled releases of radioactive materials into the environment.*
2. *Each Contracting Party shall take appropriate steps to ensure that discharges shall be limited:*
  - (i) *to keep exposure to radiation as low as reasonably achievable, economic and social factors being taken into account; and*

*(ii) so that no individual shall be exposed, in normal situations, to radiation doses which exceed national prescriptions for dose limitation which have due regard to internationally endorsed standards on radiation protection.*

*3. Each Contracting Party shall take appropriate steps to ensure that during the operating lifetime of a regulated nuclear facility, in the event that an unplanned or uncontrolled release of radioactive materials into the environment occurs, appropriate corrective measures are implemented to control the release and mitigate its effects.*

The fundamental radiation protection criteria are detailed in the draft Basic Ionising Radiation Control Regulations of the NRA. In case of exposures from any particular source within a facility, radiation protection and safety shall be optimised by the authorised person in order to ensure that the magnitude of individual doses, the number people exposed and the likelihood of incurring potential exposures are kept as low as reasonably achievable, taking into account economic and social factors, being within the restriction that the dose to individuals delivered by the source is subject to dose constraints. These include prescribing of dose limits for workers and members of the public as well as the setting of dose constraints for public exposure.

#### **F.4.1. Dose Limits**

##### **a) Occupational Exposure**

The occupational exposure of any worker shall be so controlled that the following limits are not exceeded:

- an (average) effective dose of 20 mSv per year averaged over five consecutive years;
- a (maximum) effective dose of 50 mSv in any single year;
- an equivalent dose to the lens of the eye of 150 mSv in a year; and
- an equivalent dose to the extremities (hands and feet) or the skin of 500 mSv in a year.

##### **b) Apprentices and Students**

For apprentices of 16 to 18 years of age who are undergoing training for employment involving exposure to radiation and for students of age 16 to 18 who are required to use sources in the course of their studies, the occupational exposure shall be so controlled that the following limits are not exceeded:

- an effective dose of 6 mSv in a year;
- an equivalent dose to the lens of the eye of 50 mSv in a year; and
- an equivalent dose to the extremities or the skin of 150 mSv in a year.



### **c) Public Exposure**

Exposure of members of the public attributable to practices shall not exceed the following limits which shall apply to the estimated average doses to the relevant critical groups:

- an effective dose of 1mSv in a year;
- an equivalent dose to the lens of the eye of 15mSv in a year; and
- an equivalent dose to the extremities or the skin of 50 mSv in a year.

### **F.5 Article 25: Emergency Preparedness**

*1. Each Contracting Party shall ensure that before and during operation of a spent fuel or radioactive waste management facility there are appropriate on-site and, if necessary, off-site emergency plans. Such emergency plans should be tested at an appropriate frequency*

*2. Each Contracting Party shall take the appropriate steps for the preparation and testing of emergency plans for its territory insofar as it is likely to be affected in the event of a radiological emergency at a spent fuel or radioactive waste management facility in the vicinity of its territory.*

The NRA requires the establishment of an emergency preparedness and response plan for any facility or activity for which authorisation is sought. The NRA ensures that such emergency plans are effective for the protection of persons should an accident occur. The emergency plan includes a description of facilities, identification of conditions that could create a need for emergency intervention, training and exercising arrangements, and liaison with off-site authorities as well as relevant national and international organizations and emergency preparedness provisions.

The National Disaster Management Organisation (NADMO), in collaboration with the NRA and GAEC has a Radiological and Nuclear Disaster Committee which provides advice and logistical support in case of a radiological or nuclear emergency.

### **F.6 Decommissioning**

#### **Article 26: Decommissioning**

*Each Contracting Party shall take the appropriate steps to ensure the safety of decommissioning of a nuclear facility. Such steps shall ensure that:*

- qualified staff and adequate financial resources are available;*
- the provisions of Article 24 with respect to operational radiation protection, discharges and unplanned and uncontrolled releases are applied;*
- the provisions of Article 25 with respect to emergency preparedness are applied; and*
- records of information important to decommissioning are kept*

Sections 52-55 of **Act 895** require an applicant for authorization to construct and operate a nuclear facility at the design stage to prepare an initial decommissioning plan for approval. The decommissioning plan should be commensurate with the type and status of the facility and hazards that may be associated with its decommissioning.

The initial decommissioning plan must include a generic study, indicating the feasibility of decommissioning taking cognisance of environmental aspects of decommissioning, such as the management of waste and radioactive effluents and provide a basis to assess the costs of the decommissioning activities and the means of financing it.

The authorised person is obliged to maintain a management and human resource development system to ensure that decommissioning can be completed safely and that responsible persons possess the necessary skills, expertise and training relevant to safe decommissioning.

A final decommissioning plan is submitted to the NRA for approval two (2) years before cessation of the authorised facility which must be supported by an appropriate safety and environmental considerations necessary for implementation of the decommissioning activities. The decommissioning plan shall include a description of the options, overall timescales for the decommissioning of the facility and the end-state after completion of all decommissioning activities and shall explain the reasons for the preferred option.

Decommissioning cost estimates are required to be performed periodically during the operational lifetime of authorised facilities, in order to provide up to date cost estimates, identify critical factors impacting on these estimates, and assess the basis for financing decommissioning.

## Section G. Safety of Spent Fuel Management

### G.1 General Safety Requirements

#### Article 4: General safety requirements

*Each Contracting Party shall take the appropriate steps to ensure that at all stages of spent fuel management; individuals, society and the environment are adequately protected against radiological hazards. In so doing, each Contracting Party shall take the appropriate steps to:*

*(i) ensure that criticality and removal of residual heat generated during spent fuel management are adequately addressed;*

*(ii) ensure that the generation of radioactive waste associated with spent fuel management is kept to the minimum practicable, consistent with the type of fuel cycle policy adopted;*

*(iii) take into account interdependencies among the different steps in spent fuel management;*

*(iv) provide for effective protection of individuals, society and the environment, by applying at the national level suitable protective methods as approved by the regulatory body, in the framework of its national legislation which has due regard to internationally endorsed criteria and standards;*

*(v) take into account the biological, chemical and other hazards that may be associated with spent fuel management;*

*(vi) strive to avoid actions that impose reasonably predictable impacts on future generations greater than those permitted for the current generation;*

*(vii) aim to avoid imposing undue burdens on future generations.*

#### G.1.1. Criticality and removal of residual heat generated during spent fuel management

The Nuclear Regulatory Authority Act, 2015 (**Act 895**) empowers the NRA to take appropriate steps to ensure that at all stages of spent fuel management, individuals, society and the environment are adequately protected against radiological hazards by taking appropriate steps to;

(a) ensure that criticality and removal of residual heat generated during spent fuel management are adequately addressed;

(b) ensure that the generation of radioactive waste associated with spent fuel management is kept to a practicable minimum level; and

(c) take into account interdependencies among the different steps in spent fuel management.

Ghana operates a 34-kW tank-in-pool research reactor, which uses Low Enriched Uranium (HEU) as fuel. The Nuclear Reactors Research Centre (NRRC) of National Nuclear Research Institute (NNRI) of GAEC, operator of Ghana Research Reactor-1 (GHARR-1) has converted the reactor core in response to the global trend in converting research and test reactors from the use of High Enriched Uranium (HEU) to Low Enriched Uranium (LEU) in civil nuclear applications. The project was carried out with support from the United States Department of

Energy (US DOE), Government of the People’s Republic of China and Ghana through various Laboratories and Institutions and well as the IAEA. To ensure safety and security of the conversion activities, the Nuclear Regulatory Authority (NRA) collaborated with other regulatory authorities in the industry.

The reactor with LEU core went critical on July 13, 2017 at 13:23 GMT and subsequently got to full power on August 10, 2017 at 12:27 GMT. Several related experiments were conducted to ensure the reactor safety and nominal flux was not compromised.

The operator (GAEC) is reviewing the Decommissioning Plan to accommodate the change in fuel from HEU to LEU.

### **G.1.2. The Generation of Radioactive Waste Associated with Spent Fuel Management**

Currently there is no spent fuel management activity in Ghana.

### **G.1.3. Interdependencies Among the Different Steps in Spent Fuel Management**

The Draft Policy and Strategy for Radioactive Waste Management outlines a framework within which decisions involving interdependencies management steps will be made. The best practices in the nuclear industry will be considered for the future spent fuel management activities in Ghana, especially with regards to disposal.

### **G.1.4. Effective Protection of Individuals, Society and The Environment by Application of Protective Methods as Approved by The Regulatory Body**

The Draft Basic Ionizing Radiation Control Regulations developed by NRA prescribes dose and risk criteria applicable to workers and members of the public, as well as general safety principles, such as defence-in-depth, ALARA and conformance to good engineering practice. The dose criteria, discussed in Section F-4, are applied in accordance with international best practice (e.g. ICRP, IAEA).

### **G.1.5. Biological, Chemical and Other Hazards Associated with Spent Fuel Management**

The prime responsibility for managing radioactive waste including spent nuclear fuel rests with the authorized person per the Nuclear Regulatory Authority Act, 2015 (Act 895).

The waste generators are responsible for characterizing the wastes they generate. The aim of characterization is to define the properties sufficiently to allow the waste to be accepted for successive waste management steps, and ultimately to meet waste acceptance criteria for the disposal facility. Waste characterization requirements cover the establishment of physical, chemical, biological and radiological properties to determine the waste processing needs and

the ultimate suitability of a waste package for storage and disposal. Waste characterization data and records are used for verification and quality assurance purposes.

The NRA shall be satisfied that this has been performed adequately. Demonstration of an adequate characterisation regime is aided by the application of a management system that produces, records that are reliable, traceable and retrievable.

#### **G.1.6. Avoidance of Actions That Impose Reasonably Predictable Impacts on Future Generations Greater Than Those Permitted for The Current Generation**

The Republic of Ghana is committed to management of radioactive waste in a manner that protects human health and the environment, now and in the future in accordance with the following fundamental principles (Nuclear Energy Basic Principles):

- Protection of human health: Radioactive waste shall be managed in such a way as to secure an acceptable level of protection for human health.
- Protection of the environment: Radioactive waste shall be managed in such a way as to provide an acceptable level of protection of the environment, including natural resources.
- Protection beyond national borders: Radioactive waste shall be managed in such a way as to assure that the possible effects on human health and the environment beyond national borders will be considered.
- Protection of future generations: Radioactive waste shall be managed in such a way that predicted impacts on the health of future generations will be within relevant levels of impact that are acceptable today.
- Burdens on future generations: Radioactive waste shall be managed in such a way that will not impose undue burdens on future generations.
- National legal framework: Radioactive waste shall be managed within an appropriate national legal framework, including clear allocation of responsibilities and the provision for effectively independent regulatory functions.
- Control of radioactive waste generation: Generation of radioactive waste shall be kept to the minimum practicable.
- Safety of facilities: The safety of facilities for radioactive waste management shall be appropriately assured and regulated throughout its lifetime.

#### **G.1.7. Aim to Avoid Imposing Undue Burdens on Future Generations**

The draft Policy and Strategy embodies the principle of no undue burden on future generations. In line with this principle, final disposal is regarded as the ultimate step in radioactive waste management, although a stepwise waste management process is acceptable.

Investigations shall be conducted, by Ghana Atomic Energy Commission and the potential nuclear power operator, to consider the various options for the safe management of spent nuclear fuel, and the following options will be investigated:

- Repatriation to the country of origin or supplier;
- Long-term above ground storage in an off-site facility licenced for this purpose;
- Deep geological disposal

## **Section H. Safety of Radioactive Waste Management**

### **H.1 General Safety Requirements**

#### **Article 11: General safety requirements**

*Each Contracting Party shall take the appropriate steps to ensure that at all stages of radioactive waste management individuals, society and the environment are adequately protected against radiological and other hazards.*

*In so doing, each Contracting Party shall take the appropriate steps to:*

*(i) ensure that criticality and removal of residual heat generated during radioactive waste management are adequately addressed;*

*(ii) ensure that the generation of radioactive waste is kept to the minimum practicable;*

*(iii) take into account interdependencies among the different steps in radioactive waste management;*

*(iv) provide for effective protection of individuals, society and the environment, by applying at the national level suitable protective methods as approved by the regulatory body, in the framework of its national legislation which has due regard to internationally endorsed criteria and standards;*

*(v) take into account the biological, chemical and other hazards that may be associated with radioactive waste management;*

*(vi) strive to avoid actions that impose reasonably predictable impacts on future generations greater than those permitted for the current generation;*

*(vii) aim to avoid imposing undue burdens on future generations.*

#### **H.1.1. Criticality and Residual Heat Removal**

Provisions in both the Nuclear Regulatory Authority Act, 2015 (Act 895) and in the Draft Radioactive Waste Management Regulations ensure that all facilities in the country involved in radioactive waste management address the issues of criticality and heat generated during waste management as well as ensure that the wastes generated are kept as low as reasonably practicable (ALARP).

In accordance with the Nuclear Regulatory Authority Act, 2015 (Act 895), the authorised person shall prepare and document a safety and security case including appropriate safety assessments for the NRA to review and approve in order to obtain authorisation. The safety case and the supporting safety assessments shall demonstrate the level of protection provided and also provide assurance that safety, security and safeguards (where applicable) requirements will be met. The safety case shall address the criticality and residual heat removal. The level of detail of the information comprising the safety and security cases shall be commensurate with the complexity of the facility and its potential impacts.

### **H.1.2. Minimisation of Radioactive Waste**

The draft National Policy and Strategy for the Republic of Ghana addresses the issues of waste minimisation and requires that generation of radioactive waste should be kept to the minimum practicable in terms of activity and volume by the application of design, operating and decommissioning measures. Wastes are segregated by physical, chemical, radiological and biological characteristics in order to reduce volumes and facilitate good practice in radioactive waste management.

In this regard, users of radioactive materials are encouraged to prioritize the reuse and recycling of these materials or their disposal as non-radioactive waste in compliance with the regulatory requirements on exemption and clearance.

### **H.1.3. Interdependencies in Radioactive Waste Management**

The draft National Policy and Strategy, and the Draft Radioactive Waste Management Regulations for the Republic of Ghana incorporates the principle that interdependencies among all steps in radioactive waste generation and management shall be appropriately taken into account.

The draft National Policy and Strategy requires radioactive waste management organisation to ensure that radioactive wastes received are managed using the most suitable options from predisposal to disposal. Non-conformities in earlier processes (e.g., the predisposal processes) may impact on later processes (e.g., final disposal). Correction of such non-conformities in a retrospective manner may not always be possible or effective. Integrated management systems (IMS) to facilitate the planning, control and supervision of all aspects of radioactive waste management which aims to prevent harmful effects on current and future generations has been considered.

Interdependencies in the generation and management steps are thus managed through the preparation of a radioactive waste management programme and quality management plan. The waste management programme identifies waste streams and endpoints and ensures that waste management and transport steps meet requirements of the NRA.

### **H.1.4. Protection of Individuals, Society and the Environment**

The primary responsibility for the protection of the public and the environment from the harmful effects of ionizing radiation rests with the authorised person.

The NRA regulates the introduction of radiation sources, nuclear materials, equipment or practices that expose workers, patients, the public and the environment to radiation. The NRA provides for protection of persons, property and the environment against nuclear damage through the establishment of regulations, safety standards and regulatory guidelines.



In developing its regulations, standards and guidance the NRA takes due account of international standards and criteria, in particular the safety standards of the IAEA, recommendations from the ICRP and reports from UNSCEAR.

The fundamental safety objective of protecting people and the environment has to be achieved without unduly limiting the operation of facilities or the conduct of activities that give rise to radiation risks.

#### **H.1.5. Biological, Chemical and Other Hazards**

Wastes are segregated by physical, chemical, radiological and biological characteristics in order to facilitate good radioactive waste management practice.

The RWMC employs a radioactive waste characterisation process for characterising radiological, chemical, mechanical, thermal and biological properties of radioactive wastes. These characteristics are used to categorise the waste in order to determine the applicable processing and disposal options.

Most of the radioactive waste held in the Republic of Ghana consists of disused sealed radioactive (including orphan) sources. Because these contain only one radionuclide, characterization is simple, and measurement of source strength can usually be compared with values calculated from information contained in the documentation that accompanies the source.

Characterization of laboratory wastes is similarly straightforward because only one or two radionuclides are likely to be present and, again, measurements can be compared with calculated values.

#### **H.1.6. Protection of Future Generations**

The Nuclear Regulatory Authority Act, 2015 (Act 895) requires radioactive waste to be managed in such a way that the predicted impact on future generations will not be greater than those permitted for current generation. This conforms with the fundamental principle of radioactive waste management (Nuclear Energy Basic Principles).

Disposal is regarded as the ultimate step in the radioactive waste management process, although a stepwise waste management process is acceptable. Permanent containment and isolation for radioactive waste repository cannot be guaranteed over long time periods. It is possible that some fraction of the waste inventory may migrate to the biosphere, potentially giving rise to exposures in future years. Doses to individuals and populations over long time-scales can only be estimated and the reliability of these estimates decrease as the time period into the future increases. The Post-Closure Radiological Safety Assessment (PCSA) for the Borehole Disposal Facility being implemented for disposal of disused sealed radioactive sources (DSRS) is giving consideration to various long- and short-term intrusion and exposure

scenarios to ensure that the dose to the most exposed individual (inadvertent intrusion) would still be within prescribed limits.

### **H.1.7. No Undue Burden on Future Generations**

In accordance with the Nuclear Regulatory Authority Act, 2015 (Act 895) and Draft National Policy and Strategy for the Republic of Ghana, radioactive waste shall be managed in such a way that will not impose undue burdens on future generations. Ghana has adopted the “Polluter Pays Principle”, this ensures that the financial burden for the management of radioactive waste is borne by the generator of the waste.

The following waste management options shall be followed where practicable in accordance with national regulations, ALARA principle and other international guidance:

- Waste Minimisation
- Storage
- Treatment, Conditioning and Disposal

Decommissioning and closure of facilities shall be implemented as soon as practicable in order to minimise the burden on future generations.

## **H.2 Existing Facilities and Past Practices**

### **Article 12: Existing facilities and past practices**

*Each Contracting Party shall in due course take the appropriate steps to review:*

*(i) the safety of any radioactive waste management facility existing at the time the Convention enters into force for that Contracting Party and to ensure that, if necessary, all reasonably practicable improvements are made to upgrade the safety of such a facility;*

*(ii) the results of past practices in order to determine whether any intervention is needed for reasons of radiation protection bearing in mind that the reduction in detriment resulting from the reduction in dose should be sufficient to justify the harm and the costs, including the social costs, of the intervention.*

#### **H.2.1. Safety of Existing Radioactive Waste Management Facilities**

The conditions of authorisation for nuclear and radiological installations by NRA requires the authorised person to establish and implement processes for the periodic and systematic review and reassessment of safety and security case submitted.

In addition to such reviews, the safety and security case shall be reviewed and updated:

(a) when there is any significant change that may affect the safety, security and safeguards (where applicable) of the facility or activity e.g. safety or security upgrades or facility modifications;

(b) when there are significant developments in knowledge and understanding (such as developments arising from research or operational experience feedback); and

(c) when there is an emerging safety, security and safeguards (where applicable) issue owing to a regulatory concern or an incident.

The radioactive waste management practiced in Ghana entails reception of radioactive waste, characterization and safe storage, pending the development a disposal facility. The Radioactive Waste Management Centre (RWMC) operates a Centralised Radioactive Waste Management Facility (CRWMF) for safe and secure management of radioactive waste. Assessment and demonstration of safety for the facility and activities require a safety case together with the necessary supporting safety assessment.

A safety case and associated safety assessment document has been developed by RWMC/GAEC and submitted to the NRA in support of an application for a license to continue with the operation of the CRWMF. The RWMC assessed the safety of the facility and demonstrated that the design and operation of the facility are compliant with the relevant national and international safety requirements.

### **H.3 Siting of Proposed Facilities**

The Nuclear Regulatory Authority Act, 2015 (Act 895), requires that an applicant wishing to site a nuclear installation must submit a site safety report to the Nuclear Regulatory Authority (NRA), which will sufficiently characterise the site and demonstrate that the safety requirement of the NRA could be met in respect of the design and operations. The site safety report shall address the following topics:

- description of site and environs;
- population growth and distribution;
- land-use;
- the frequency and severity of external natural and human induced events and the phenomena that could affect the safety of the facility;
- the foreseeable evolution of natural and man-made factors in the proposed area that may have a bearing on safety during the projected life span of the facility;
- hydrology, geology and seismology.

The Borehole Disposal System for long term management of DSRs is the radioactive waste management option currently under consideration in Ghana.

The GAEC Research Reactor site at Kwabenya has been earmarked to host the repository. The GAEC site has therefore been characterized to provide information on the geoscientific and environmental conditions that affect both the suitability of the site for the disposal purpose and

the performance of the host rock as a natural barrier. The site characterization activities involved both surface and subsurface investigations based on geological, hydrogeological, geophysical, and hydrochemical investigation methods and aimed to characterize the bedrock and groundwater properties. Two test boreholes drilled to depths of 150 m each, facilitated the subsurface investigation.

The results of the site investigations are discussed in the Site Characterization Report. It provides sufficient understanding of the site to allow the development of models that will demonstrate the site's suitability for deployment of the BDS. As such, it is a component of the Safety Case documentation to be submitted for a licence application for implementation of the Borehole Disposal System in Ghana.

### **H.3.2. Evaluation of The Safety Impact of a Facility on Individuals, Society and The Environment, After Closure**

A post-closure safety assessment (PCSA) of the Borehole Disposal System has been undertaken. The assessment was based on the IAEA Improvement of Safety Assessment Methodologies (ISAM) and demonstrated that the post-closure impact would be acceptable in terms of the current dose limits. The AMBER software developed by Quintessa was used to implement the assessment model. Disposal will be at a depth of at least 140 metres in basement rocks comprised of the Togo and Dahomeyan geological formation, both of which are of Precambrian age. Peak dose rates for the Design Scenario and various defect scenarios have been calculated. The assessment indicates that the inventory of disused sealed sources can be safely and permanently disposed using the Borehole Disposal System.

## **H.4 Design and Construction of Facilities**

### **Article 14: Design and Construction of Facilities**

*Each Contracting Party shall take the appropriate steps to ensure that:*

*i. the design and construction of a radioactive waste management facility provides for suitable measures to limit possible radiological impacts on individuals, society and the environment, including those from discharges or uncontrolled releases;*

*ii. at the design stage, conceptual plans and, as necessary, technical provisions for the decommissioning of a radioactive waste management facility other than a disposal facility are taken into account;*

*iii. at the design stage, technical provisions for the closure of a disposal facility are prepared;*

*iv. the technologies incorporated in the design and construction of a radioactive waste management facility is supported by experience, testing or analysis.*

The requirements of preconstruction, construction and commissioning of a nuclear installation are prescribed in the Nuclear Regulatory Authority Act, 2015 (Act 895) and forms the basis for the stipulation of the regulatory requirements for the design and construction of nuclear installations.

The NRA shall before authorising the construction of a nuclear installation review and assess the site evaluation (characterization) report to confirm its acceptability and related information needed for the design of the proposed facility as well as assess the basic design of the proposed facility to confirm that it meets the relevant safety, security and physical protection requirement.

Following the construction of a nuclear installation, the NRA shall review and assess the development of the facility design through documentation submitted by the operator to determine its continued acceptability.

In compliance with the Nuclear Regulatory Authority Act, 2015 (Act 895), the RWMC/GAEC is preparing a safety case documentation for submission to the NRA to demonstrate the long-term safety of the Borehole Disposal System (BDS) for management of DSRS. The safety case documentation will also demonstrate the level of protection of people and the environment and also provide assurance to the Nuclear Regulatory Authority and other State Regulatory Agencies that the safety, security and safeguards (where applicable) requirements will be met.

The safety case documentation has the following components:

- safety and security case;
- post-closure safety assessment (PCSA);
- operational safety assessment and associated procedures;
- site characterization report;
- Quality management system and
- engineering design of the BDS

The facility shall be constructed in accordance with the design described in the approved safety and security case and supporting safety and security assessment. It shall be constructed in such a way as to preserve the post-closure safety and security functions of the host environment that have been shown to be important by the safety and security case. The construction activities shall be carried out to ensure safety and security during the operational period.

## **Section I. Trans-boundary Movement**

### **Article 27. Trans-boundary Movement**

The Ghanaian legislation prohibits importation of radioactive waste materials. The legislation however encourages the return of disused sealed radioactive sources and spent nuclear fuel to the original supplier or manufacturer. Transportation of radioactive materials require authorization from the NRA according to Act 895 and the draft Transport regulations. The draft transport regulation is undergoing review by stakeholders.

The Regulation complies with requirements prescribed in the Regulations for the Safe Transport of Radioactive Material (2012 Edition)) published by the International Atomic Energy Agency (IAEA 2012).

## **Section J. Disused Sealed Sources**

### **Article 28: Disused sealed sources**

*1. Each Contracting Party shall, in the framework of its national law, take the appropriate steps to ensure that the possession, remanufacturing or disposal of disused sealed sources takes place in a safe manner.*

*2. A Contracting Party shall allow for re-entry into its territory of disused sealed sources if, in the framework of its national law, it has accepted that they be returned to a manufacturer qualified to receive and possess the disused sealed sources.*

Possession of sealed radioactive source in Ghana requires authorization and falls under the regulatory control of the NRA. The first priority in the management of disused sealed radioactive sources (DSRS) in Ghana is to reduce the rate of increase of DSRSs needing long-term management in the Republic of Ghana. To facilitate this, the NRA applies the IAEA Code of Conduct on the Safety and Security of Radioactive Sources to imported sealed radioactive sources. In such cases importation contracts include a clause which permits the return of the source to the supplier and a copy of the contract shall be submitted to the NRA before the radioactive source is imported or otherwise acquired. In addition, importers are required to provide a financial bond that will fund the repatriation of these sources when they are no longer needed. The amount of this bond will be set by the NRA. DSRS that cannot be repatriated will be managed in a licensed facility followed by permanent disposal in a suitably designed licensed disposal facility.

Currently, the RWMC facilitates decay storage for very short-lived sources and provides safe and secure storage for all the long-lived sources until an authorized disposal facility becomes available in the Republic of Ghana.

The Government of Ghana through GAEC, as part of its long-term management strategy for DSRS, has opted for the IAEA developed Borehole Disposal System (BDS) as an end-point management option. A site at Ghana Atomic Energy Commission Research Reactor site at Kwabenya have been selected as the repository site.

A safety case documentation is being developed to demonstrate that the BDS provides a safe and secure solution for the long-term management of the DSRSs in currently in storage at the Centralised Radioactive Waste Management facility, and that the performance and safety assessments are fully consistent with all the legal and regulatory requirements related to long-term safety as set out in Nuclear Regulatory Authority Act, 2015 (Act 895) and draft National Radioactive Waste Management regulations.

Detection and recovery of orphan (ownerless) sources are the responsibility of the Nuclear Regulatory Authority (NRA). The NRA hands over the recovered material to GAEC which, on behalf of the Government, manages it safely and securely.

In addition to the internationally accepted principles, the policy and principles for radioactive waste management in Ghana include the following:

- The generator of radioactive waste shall have the primary responsibility for the management of the waste generated.
- The financial burden for the management of radioactive waste shall be borne by the generator of that waste.

### **Section K. Planned Activities to Improve Safety**

For the purpose of improving the safe management of radioactive waste and management of spent nuclear fuel, Ghana has plans to:

- Approved the Draft Radioactive Waste Management Policy and Strategy
- Promulgate the Draft Radioactive Waste Management Regulations and Guidelines
- Implementation of the Borehole Disposal System
- Establish a Decommissioning Fund.

## Section M. ANNEXES

Annex I List of Spent Fuel Management Facilities **NONE**

Annex II List of Radioactive Waste Management Facilities 1. Centralized Waste Processing and Storage Facility located at Kwabenya and operated by Radioactive Waste Management Centre, Ghana Atomic Energy Commission

Annex III List of Nuclear Facilities in the process of being decommissioned **NONE**

Annex IV Inventory of Spent Fuel **NONE**

Annex V - Inventory of radioactive Wastes in Storage

<b>Radionuclide</b>	<b>Physical/ Chemical Form</b>	<b>No. of Sources</b>
<b>Category 3 - 5</b>		
Co-60	Metallic/solid	3
Ir-192	Metallic/solid	1
Sr-90	Ceramic/glass	32
Cs-137	Salt (Caesium chloride)	43
Am-241	Metallic	110
AmBeCs	Metallic	1
Ra-226	Metallic	4
RaBe	Metallic	2
AmBe	Metallic	8
PuBe	Metallic	12
Cd-109	Metallic	6
<b>Category 2</b>		
Co-60 (Radiotherapy)	Metallic/solid	2
Co-60 (Irradiator)	Metallic/solid	20
Co-60 (Radiotherapy)	Metallic/solid	42

Also, in storage is 218m<sup>3</sup> of H-3



Annex VI – References to Laws, Regulations, Requirements, Guides etc.

### **National**

- Radiation Protection Instrument, LI 1559
- Atomic Energy Commission Act (Act 588) 2000
- Nuclear Regulatory Authority Act (Act 895) 2015
- Draft National Radioactive Waste Management Policy and Strategy
- Draft National Radioactive Waste Management Regulation

Annex VII: References to official national & international reports related to safety

- Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, Guidelines regarding the Form and Structure of National Reports, 19 July, 2006.
- Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, Guidelines regarding the Review Process. 18 July, 2006.
- INTERNATIONAL ATOMIC ENERGY AGENCY, Classification of Radioactive Waste, Safety Standards Series No. GSG-1, IAEA, Vienna (2009)..
- INTERNATIONAL ATOMIC ENERGY AGENCY, Policies and Strategies for Radioactive Waste Management, IAEA Nuclear Energy Series No. NW-G-1.1, IAEA, Vienna (2009).
- Annex VIII: References on reports on international review missions performed at the request of a contracting party.

Mission Report on The Phase 1 Follow-Up Integrated Nuclear Infrastructure Review (INIR), 21–24 October 2019

Annex IX: Other relevant material. **NONE**