

Overview of strengthening the Nuclear Security Regimes for the Ghana Research Reactor-1 by the Ghana Atomic Energy Commission

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Introduction

Ghana Atomic Energy Commission (GAEC), owners of Ghana Research Reactor-1 (GHARR-1) over the years have engaged the necessary international policies and strategies in improving matters of nuclear security infrastructure at the facility level. GAEC was established by an Act of Parliament (Act 204) in 1963 with a mandate to be the sole authority in Ghana responsible for matters relating to peaceful uses of atomic energy and fulfilling the state's obligation on nuclear safety and security. This directive prompted GAEC to establish a Radiation Protection Board (RPB) with a nuclear regulatory status to help it fulfil its mandate. By this development placed GAEC in unfortunate position of playing a dual role as an operator and regulator simultaneously which fell short of best practices internationally. This abnormally was corrected by the advent of a new independent regulator (Nuclear Regulatory Authority (NRA)) in 2015. Guided by these regulatory guidelines, GAEC acquired GHARR-1 which is a commercial version of the Chinese Miniature Neutron Source Reactor (MNSR) and belongs to the class of tank-in-pool type reactors in 1994. Since, the advent of GHARR-1, GAEC has shown a strong commitment in enhancing its nuclear security infrastructure through: commitment to non-proliferation; core conversion; state-of-the-art physical protection system; Plans for boosting human resource in nuclear security; international cooperation and development of a site security plan for GAEC among others. Notwithstanding all these efforts areas like: cyber security; outside threat information and also lack of funds for nuclear security activities needed to be addressed.

Background and Functions of GAEC

Ghana officially began its nuclear programmes by the establishment of the Ghana Atomic Energy Commission (GAEC) by an act of Parliament (Act 204) in 1963. The Act (Act 204) establishing GAEC gave it the power to be the sole authority in Ghana responsible for matters related to peaceful uses of atomic energy. The state's vision in this regard was for GAEC to become the leading organization in the country contributing to sustainable national prosperity through the effective utilization of nuclear technology and other related technologies. In pursuance of this vision the government replaced Act 204 with Act 588 in year 2000. The new Act (Act 588) was for GAEC to expand its nuclear programmes so as to engage in biotechnology and other related technologies for economic development through: advising government on policy issues relating to peaceful use of nuclear energy in Ghana; development of the human resource base in nuclear science, biotechnology and related fields; commercialization of research in the areas of health, agriculture, industry and commerce among others. Finally, one of the important roles was for GAEC to provide security to radioactive and nuclear materials.

Characteristics of the Ghana Research Reactor-1 (GHARR-1)

GHARR-1 is a commercial version of the Chinese Miniature Neutron Source Reactor (MNSR) and belongs to the class of tank-in-pool type reactors (Fig. 2). It is acquired by GAEC in 1994 from the Chinese Institute of Atomic Energy (CIAE). The core region of GHARR-1 is located 4.7 m under water close to the bottom of a watertight reactor vessel. The quantity of water in the vessel, serves the purpose of radiation shielding, moderation and as well as primary heat transfer medium. Currently, the reactor core has undergone conversion which has resulted in the change of some safety specifications. For instance, the uranium enrichment has change from 90.2 % in the old core to 13 % in the new core. Similarly: its rated power change from 30 kW to 34 kW; Number of fuel pins (344 to 335); Fuel meat (U-Al₄ to UO₂); and Cladding Material (Al-303 to Zr-4). The reactor is operated under the Nuclear Reactors Research Centre (NRRRC) by the National Nuclear Research Institute (NNRI), one of the institutes under GAEC. The reactor pool water does not only prevent the release of radioactive material into the environment in the event of an accident, but simultaneously provides a robust structure that protects the core from terrorist attack.

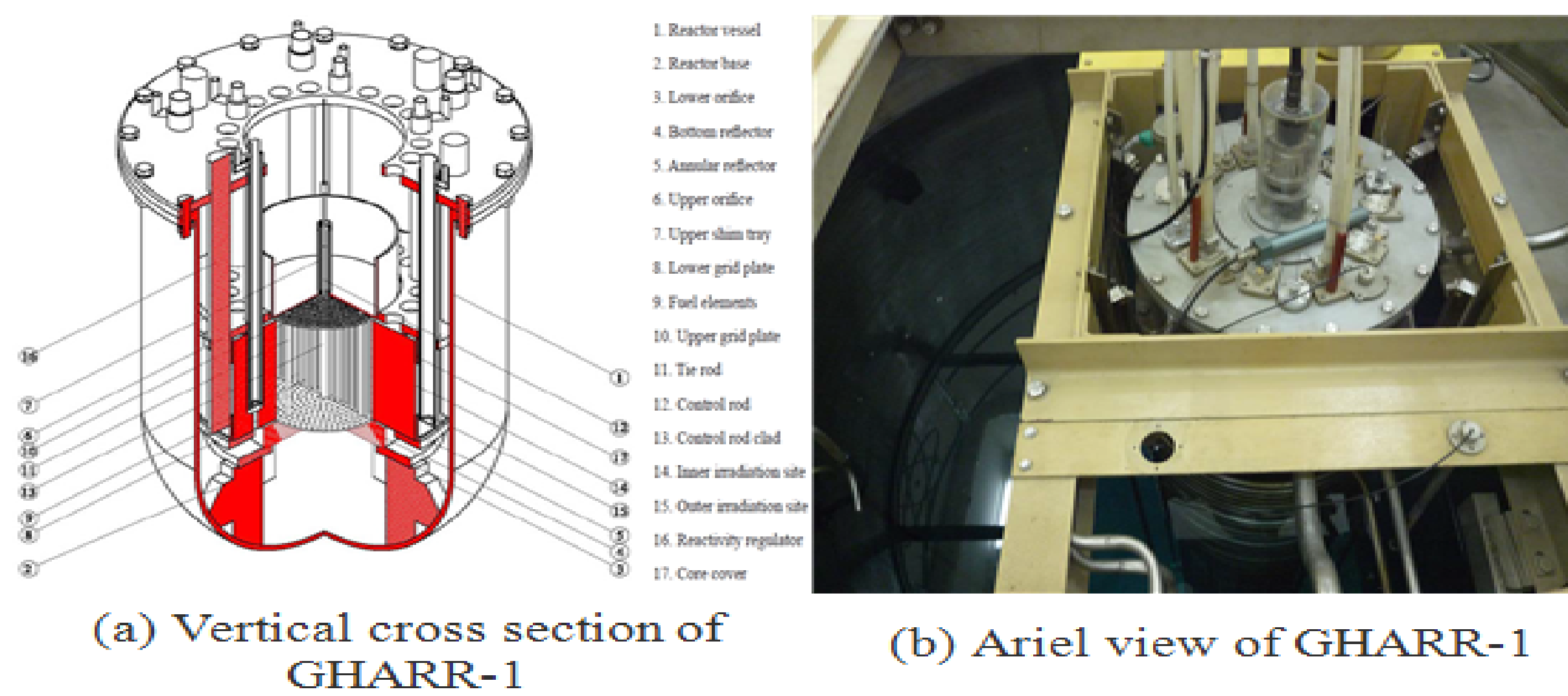


Figure 1: The Overview of GHARR-1

Nuclear Regulation Framework from Historical Perspective

For the Commission to strengthen its capabilities in order to meet its statutory responsibilities, it established a Radiation Protection Board (RPB) by Atomic Energy Amendment Law (PNDCL 308) in 1993 as a national nuclear regulatory authority.

Functions of RPB

The PNDCL 308 prescribe powers and functions of the RPB in terms of licensing, inspection, supervising, monitoring operations of irradiation devices, radioactive materials and ensure their safety and security. The core mandate of RPB among other was to provide an effective national framework for safety and security of radioactive sources, nuclear materials and nuclear installations. It was in recognition of this fact that GHARR-1 was licensed, supervised and regulated by RPB. Thus, GHARR-1 through the RPB has implemented safety and security policies derived from international standards. As time goes on, government realized that GAEC playing the role as an operator and regulator was a "recipe for conflict" and fell short of international best practice and the dictates of the IAEA.

Improving the Regulatory System in Support of GHARR-1 Nuclear Security Management

To further improve the regulatory system in GAEC and for that matter Ghana as a whole, the RPB was modified into an independent Nuclear Regulatory Authority (NRA) by Act 895 of Parliament in 2015. Act 895 empowered NRA to conduct inspections to assess compliance with the security of nuclear and radioactive materials and associated facilities. These arrangements have strengthened the effectiveness in the nuclear security regulatory regimes in Ghana as the NRA is currently drafting the national legislations in that regard. In addition, the creation of NRA ended GAEC role simultaneously as an operator and nuclear regulator. The NRA by virtue of its regulatory mandate is implementing policies and strategies aimed at strengthening the nuclear safety and security infrastructure capabilities of GHARR-1 and the country as a whole.

Physical Security Systems at GHARR-1

For the commission to understand, gained international recognition and appreciate better matters of nuclear security at the facility level, over the years, has signed numerous international legal instruments which include: Convention on the Physical Protection of Nuclear Material (CPPNM); and Convention on Nuclear Safety (CNS). For the prevention of malicious acts by an adversary that could result in unacceptable radiological consequences, GAEC has in place a credible strategy which includes: Physical protection, personnel security and emergency response plan to deal with such matters. Currently, the major security upgrades at GHARR-1 is based on three main basic functions of physical protection systems of Prevention, Detection and Response.

Physical Barriers

Physical Barriers attempts at making the reactor hall resistant to force attack; thus, outer border of the protected area has outside walls, bars on the glass windows, locked doors and locked gate; an access control turnstile is installed in the corridor leading to the reactor hall (Fig. 2a). For the purpose of detection, a well-designed intruder detection system such as alarm sensor on the doors, vibration sensors on the walls and detection sensors on top of the reactor are installed at GHARR-1 to provide early and reliable detection of any attempted intrusion; to improve verification capabilities, CCTV cameras or video motion detection to monitor the internal areas of the reactor hall, control room and the reactor hall corridor had been installed, the video data is stored and can always be played back.

These systems are connected to the central alarm station (CAS) and monitored externally 2 km at GAEC police station which give signal of protected area violation by potential intruder. In addition, the reactor itself is protected by using strong iron metal across the pool to prevent access to the reactor vessels (Fig. 2a). For the purpose of deterrence for instance, fresh fuel for the reactor core is located at high security area physically separated from the fuel in the reactor core.



(a) Reactor crossed bar & Turnstile door

(b) Security cameras

Figure 2: Physical protection Features

Security Personnel

In the GHARR-1 facility access to the facility can be categorized into several groups which include, management, regular employees, security personnel, visitors and service providers. Thus, to check insiders' threat against sabotage and malicious use of nuclear materials, management has taken steps to put measures in place to ensure confidentiality of nuclear information, individual identification verification, reliability and trustworthiness of staff and others who have access to the facility. For instance, service providers and visitors to the facility include excursion groups, maintenance personnel, and students from tertiary educational institutions on nuclear research programmes. A policy of escorting such people is a way of making sure that they are performing their activities in accordance to their accepted proposals which brought them into the facility. For GHARR-1 staff in the category of facility management and regular staff, a strong security awareness programme is in place to the enforcement of best security practices and sustained training. The programme ensures that employees are always mindful of their security roles and responsibilities so that contrary security breaches by others are reported to ensure that offenders are brought to book and appropriate punishment is applied. For the protection of the facility, trained and qualified security guards are always at vantage points twenty-four hours each day to provide security.

Information Security

Management of GHARR-1 have sensitive information protection program that addresses valuable information that could be of worth to an adversary in the planning a malicious act. For instance, the fresh fuels of the reactor is kept and control only by the Director of NNRI. The information security ensures information control, protection measures and access restriction to vital information.

Site Security Plan for GAEC

The Commission has approved Nuclear Security Site Plan with the objective of providing general advice and guidance to the regulatory body, security guards, scientific staff and some section of employees on how to address various aspects of nuclear security in the protection of nuclear and radioactive materials. Currently, GAEC with support US Office Radiological Security (ORS) is in the process of implementing a "Site Security Plan" to boost security at its nuclear facilities at GAEC Site.

Boosting the Nuclear Security Human Resource Base for GHARR-1

The nuclear industry relies heavily on a specialized and highly trained workforce for its safety and sustainability. The IAEA over the years have made tremendous support for Member States nuclear industries in terms of education, training and finance. For the purpose of developing and sustaining the human resource base for the growing nuclear industry, Ghana indicated its intention to establish a Graduate School of Nuclear and Allied Sciences (SNAS). SNAS is a postgraduate school established by GAEC in collaboration with the University of Ghana, with support from the IAEA to enhance human resources development for the peaceful uses of nuclear and related technologies in Ghana and Africa. The School is accredited for Master of Philosophy (MPhil) and Doctor of Philosophy (PhD) programmes in nuclear sciences. Currently, almost 80 % of the workforce in nuclear science who utilizes the GHARR-1 facility are trainees from SNAS. On the part of nuclear security, SNAS is currently working to open-up nuclear security programmes to address nuclear security challenges by creating a separate department in that regard. The move will be a tremendous access for GHARR-1.

Training and Education

Each year, the NRRRC with the support of GAEC organize workshop and training programmes for GHARR-1 staff, staffs from the regulatory authority, security guards of the Commission and other nuclear facility's staffs. The objective of such events is for participants to understand the concept of radiation in terms of uses, harmful effects and need for protecting radioactive materials against theft, sabotage, unauthorized access, illegal transfer for purposes which may be detrimental to society. Most of the training and workshop events consist of a series of lectures given by experts, demonstrations involving the use of radiation sources and radiation detection equipment, and practical exercises in the classroom/laboratory or simulation exercises. Often, individual presentations are delivered that offer new perspectives and practices, adding to the overall value of the learning experience.

Eliminating the Security Risk of Highly Enrich Fuel: The Core Conversion of GHARR-1

GAEC has strong commitment for international cooperation for the peaceful uses of atomic energy. On behalf of Ghana, GAEC has signed and ratified both the Comprehensive Safeguards Agreement in 1975 and the Additional Protocol in 2004. Ghana's commitment to non-proliferation was recently demonstrated when the GAEC successfully completed the conversion GHARR-1 from the use of highly enriched uranium (HEU) fuel to a lowly enriched uranium (LEU) fuel, in an international project supported by the IAEA to help decrease the proliferation risks associated with HEU fuel. The HEU fuel has since been repatriated to the manufacturers. The conversion and repatriation of the HEU fuel is clearly an indication of Ghana's commitment to eliminate such materials from the country. Therefore, securing and eliminating stocks of HEU is the surest way to decrease the risk that terrorist groups could use to create a nuclear explosion. The conversion of GHARR-1 was the first of the Chinese base MNSR. Hence, with this pioneer engagement, GAEC has demonstrated the feasibility of the conversion of these reactors outside of China, and a commitment which is exceedingly exemplary.

Conclusion

Notwithstanding, the tremendous efforts GAEC has put in place to uplift the security status of GHARR-1, much efforts is still needed in the area of cyber security, outsider threat information and also the required funds to implement its nuclear security programmes. However, with the level of GAEC continuous commitment to engage the IAEA and other international stakeholders in matters related to nuclear security, the future still looks brighter for GAEC to maximize its nuclear security management goals.