OPERATIONAL RADIATION PROTECTION PROGRAMME AND RADIOACTIVE WASTE MANAGEMENT AT THE GHANA RESEARCH REACTOR-1 (GHARR-1)

KWAME GYAMFI

Nuclear Reactors Research Centre

National Nuclear Research Institute

Ghana Atomic Energy Commission

Regional Workshop on Application of IAEA Safety Standards on Operational Radiation Protection and Radioactive Waste Management for Research Reactors in Africa
Kinshasa, Democratic Republic of Congo
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OUTLINE OF PRESENTATION

- INTRODUCTION
- BRIEF DESCRIPTION OF FACILITY
- RADIATION PROTECTION PROGRAMME
- RADIOACTIVE WASTE MANAGEMENT
- CONCLUSIONS

INTRODUCTION

Ghana Atomic Energy Commission (GAEC) was established by an Act of Parliament (Act 204) in 1963 which has been superseded by Act 588 in 2000.

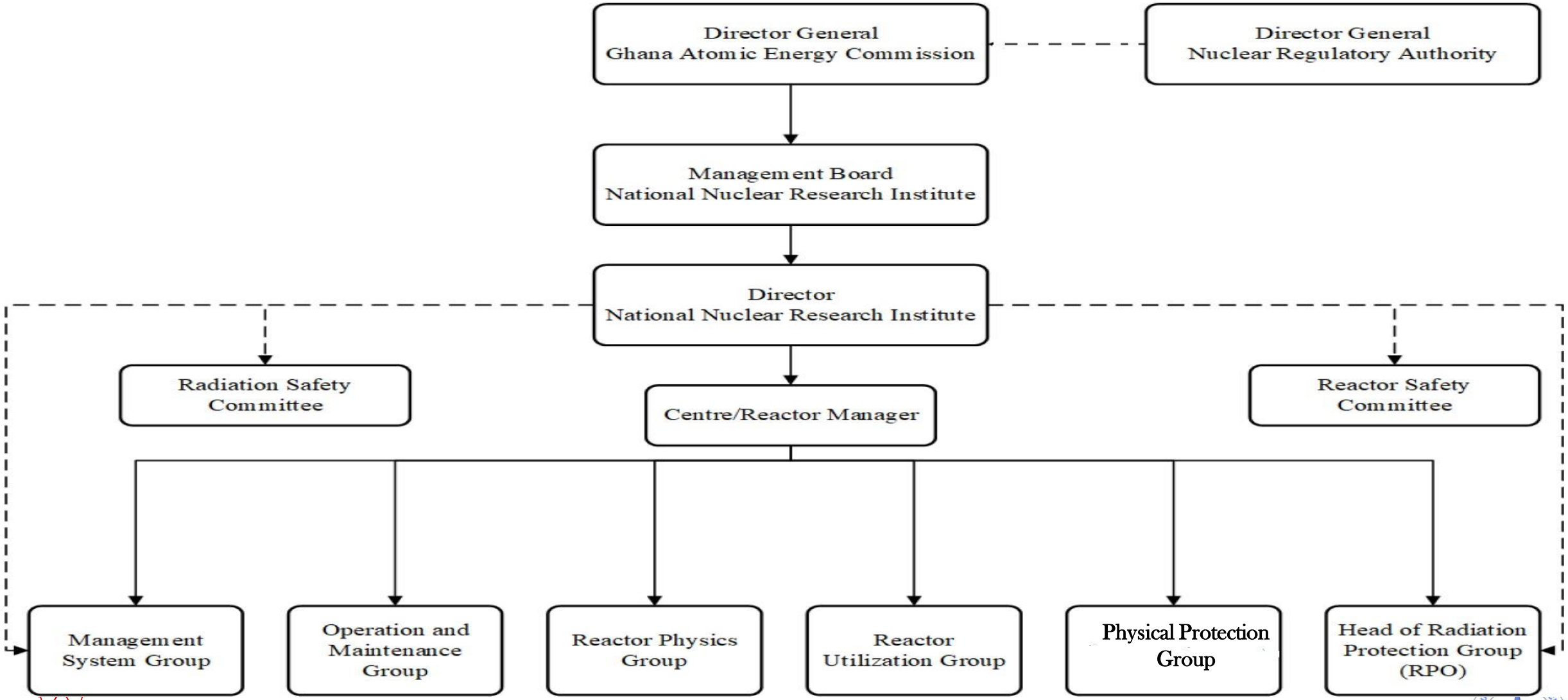
The GAEC is under the Ministry of Environment, Science, Technology and Innovation (same as the Regulatory Authority)

The main functions of the Commission include the promotion and development of peaceful application of nuclear science and related technologies for the benefit of Ghana.

To meet her objective, GAEC has seven Institutes which carry out the above-mentioned functions. **NNRI**, BNARI, NPI, RAMSRI, RPI, SSTI, SNAS

NNRI – Seven Centres including the **Nuclear Reactors Research Centre** (Mainly in charge of the Reactor Facility)

CONDUCT OF OPERATIONS

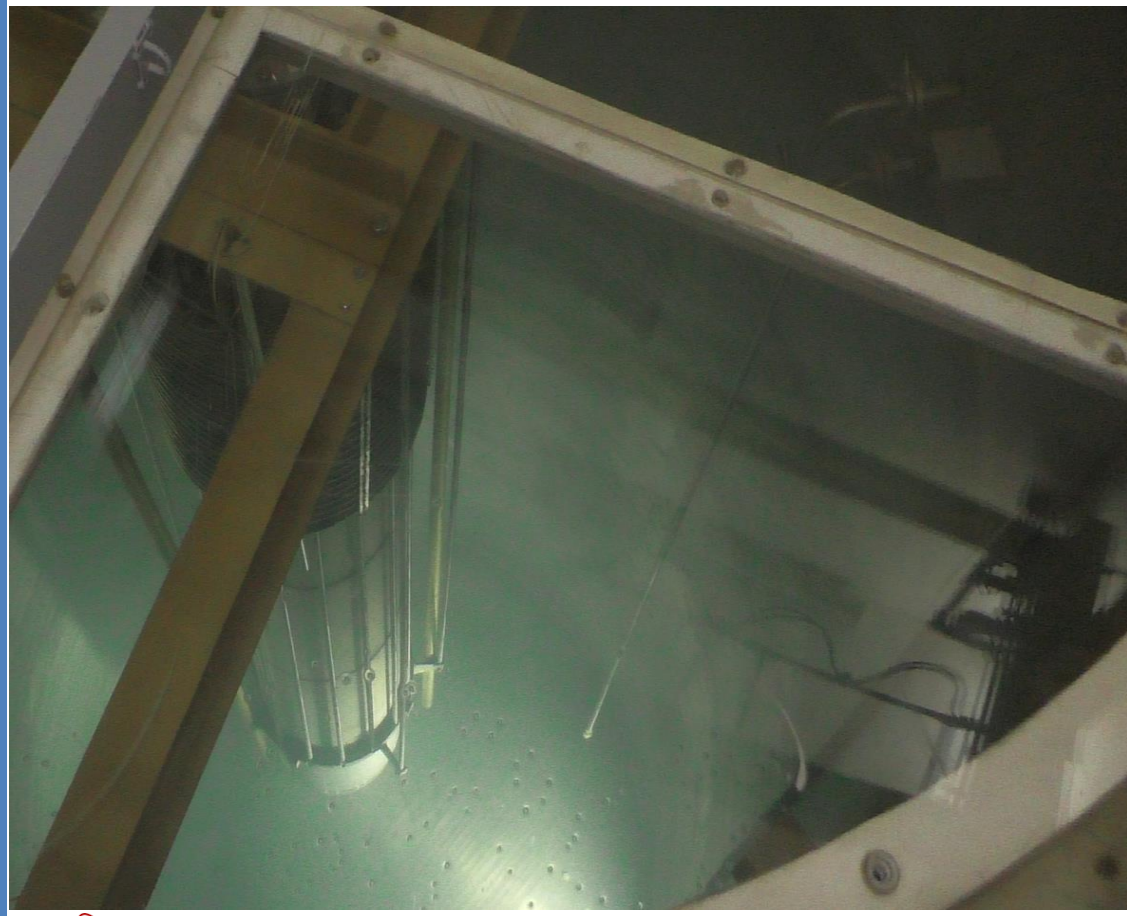


FACILITY DESCRIPTION

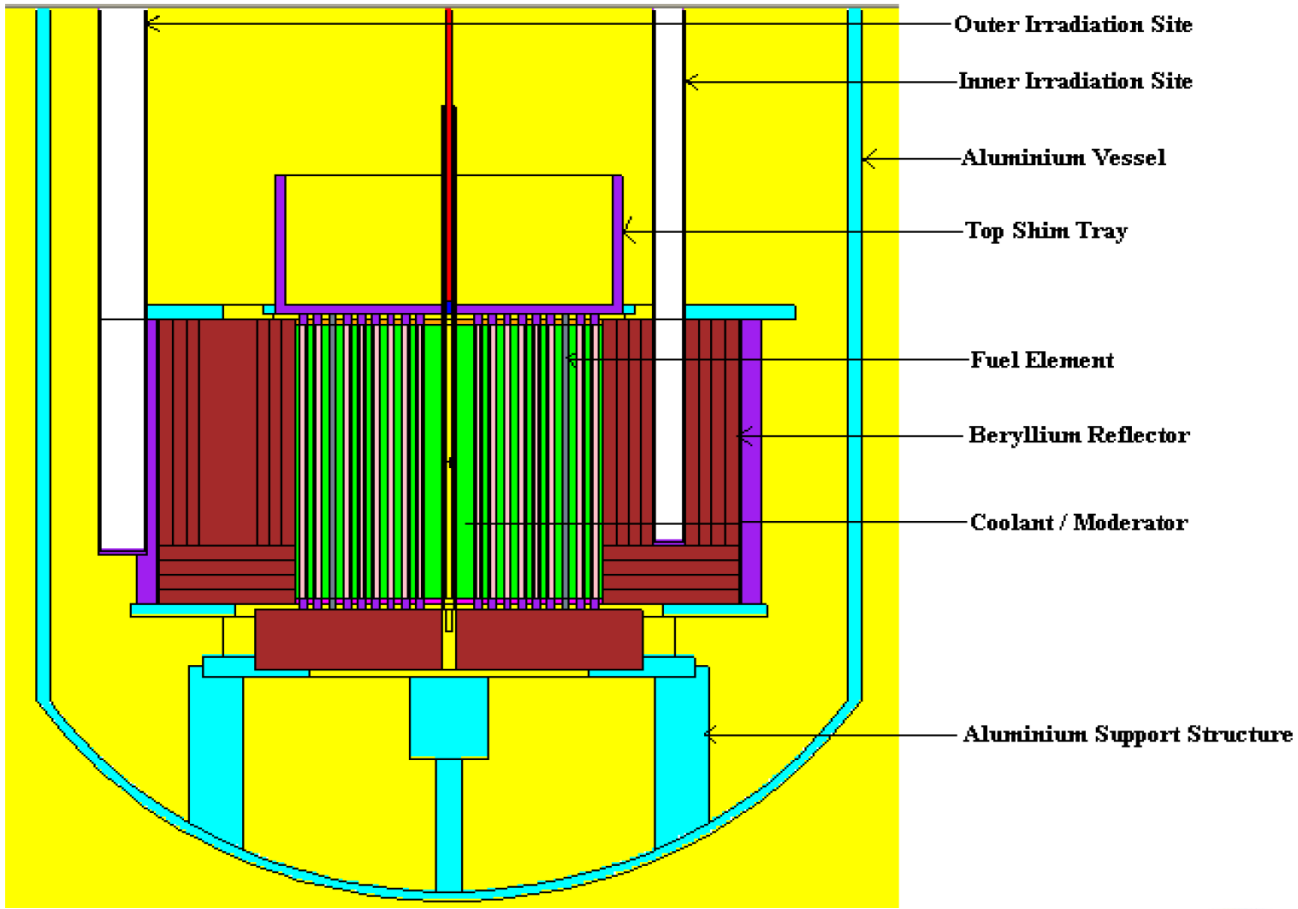
- Ghana Research Reactor-1 (GHARR-1) is owned by GAEC;
- Operating Organization is NNRI; with NRRC in charge of operation
- 2 Project and Supply Agreements: INFCIRC/468, April, 1995; INFCIRC/870, October 30, 2014
  - ✓ Installation period less than Six months; completed in Dec. 1994
  - ✓ First criticality achieved on December 17, 1994
  - ✓ Second criticality achieved on July, 13, 2017 (after Core Conversion)
- A Low Power Miniature Neutron Source Reactor (MNSR) – Features:
  - ✓34 kW power
  - ✓Tank-in-Pool Type
  - ✓Cooling is by natural convection
  - ✓Reflection is by metal Be alloy
- GHARR-1 is used mainly for:
  - ✓Research and Development
    - Neutron Activation Analysis (NAA) – proficiency tests
  - ✓Education and Training – Universities, Research Institutions, Others
  - ✓HR for NPP; – NRA, NPI, NPG,

FACILITY DESCRIPTION

Picture of the Reactor Vessel



Schematic Diagram of GHARR-1 Core



FACILITY DESCRIPTION

The Control Systems of the GHARR-1

RADIATION PROTECTION PROGRAMME

RADIATION PROTECTION PROGRAMME

The administrative aspects of the radiation protection programme is the responsibility of the Reactor Manager.

The performance of the programme is the responsibility of the Radiation Protection Officer (RPO).

The RPO has a direct reporting capability to the Director of NNRI.

The qualifications of the personnel involved in the radiation protection programme have been described in Section 13.2.1.3 of the GHARR-1 Safety Analysis Report

RADIATION PROTECTION PROGRAMME

Radiation protection policy of the NNRI at the GHARR-1 Facility

- The radiation protection policy ensure that during all operational states, radiation exposures of site personnel and the public
  - ✓ remains below the limits prescribed by the NRA and
  - ✓ is kept as low as reasonable achievable (ALARA).

- The policy also ensure mitigation of nuclear and radiological accidents resulting in overexposure.

RADIATION MONITORING

Environmental monitoring at the GHARR-1 facility covers the controlled zone (the reactor hall), supervised zone (sample preparation laboratory, counting and transfer rooms), and offices in addition to the immediate surroundings outside the NRRC.

The monitoring is conducted weekly during operational and non-operational periods.

RADIATION MONITORING

All personnel working at the facility wear Thermonuminescence Dosimetry (TLD) Badges

Badges are returned to the Radiation Protection Officer (RPO) at the Centre at the end of every month for counting by the Radiation Protection Institute (RPI) of the Commission.

Survey meters are used at the control and supervised areas of the facility.

The RPO sends the survey meters and the contamination meters out to RPI for calibration every year.

RADIATION MONITORING

- Any radiation worker receiving whole-body-equivalent exposure exceeding 1 mSv in a one-year dosimetry period will be notified in writing.

- All exposures to doses of radiation received by, and committed to, a person , organ or tissue exceeding the limit will be met with the following actions:
  - ✓ The Reactor Manager (RM) and the individual involved will be immediately notified by the Radiation Protection Officer (RPO) of the Centre.
  - ✓ The individual involved will be required to leave any work likely to add to the dose.
  - ✓ An investigation will be conducted to determine the magnitude of the dose, establish the causes of the exposure and take any action required to prevent the occurrence of similar incident.

BASIC DOSE LIMITS

- The annual dose limits take into account internal and external occupational exposures.

Occupational limits

- Annual effective dose averaged over five consecutive years – 20 mSv
- Effective dose in any single year – 50 mSv
- For pregnant women, the limit of the annual equivalent dose of 5 mSv is applied
- The administration and authorized limit of the annual effective and equivalent dose is 10 mSv for all identified radiation workers.
- When it appears that these limits have been exceeded, the RPO will conduct an investigation.

BASIC DOSE LIMITS

Pre-Planned Special Exposures

The dose received for a pre-planned special exposure for an individual will not exceed 100 mSv/event and will not exceed 250 mSv in one's lifetime.

Women of child-bearing age and persons younger than 18 years of age shall not be involved in pre-planned special exposures

Authorization requirement for pre-planned special exposures is as follows:

Dose Equivalent	Authority
<4 mSv	RPO
4–25 mSv	Reactor Manager
>25 mSv	NRA

BASIC DOSE LIMITS

Public Exposure

Annual effective dose averaged over five consecutive years – 1 mSv

Effective dose in any single year – 5 mSv

In order to ensure that releases of radioactive waste and effluents shall be ALARA, routine monitoring conducted to ensure that an effective dose of 1 mSv in one year for the general public is not exceeded.

The RPO is to ensure that radioactive content of all potential releases from the Facility shall be determined before discharge and does not lead to public exposures above 1 mSv.

BASIC DOSE LIMITS

Intervention Level

When a worker in an operation receives an unplanned dose equivalent of 2 mSv, the operations shall be stopped, and corrective measures shall be taken.

ALARA Statement

All workers occupationally exposed shall use approved procedures and engineering **(Time, Distance and shielding)** to control to ensure that the dose received are as low as reasonably achievable.

The Radiation Protection Institute (RPI) carries out calibration of radiation monitoring systems. The RPI provides TLDs for staff of the reactor facility and at also measures the dose received by each staff.

RADIATION PROTECTION PROCEDURES

- All activities in the RP programme is performed using written procedures.
- These procedures include;

  i. The method for conducting radiation surveys and air sampling;

  ii. Effluent monitoring;

  iii. Administrative measures for controlling access to radiation areas

  iv. Control of compliance with applicable regulations for the transport of radioactive materials.

  v. The method and procedures for personnel monitoring, including methods for recording, reporting and analysing results;

  vi. The programme for internal radiation exposure assessment including cases of over exposure.

  vii. The methods of handling and storage of sources, radioisotopes or other radioactive material,

  viii. The handling and disposal of radioactive waste.

RADIATION PROTECTION TRAINNIG PROGRAMME

- A training programme for the radiation protection management and staff, experimenters and students is established.
- The course is structured to include facility walk-throughs, talks and presentations.
- The course provides participants with in-depth knowledge of various aspects related to radiation protection and safety that are relevant to personnel working at the facility.

RADIATION PROTECTION TRAINNIG PROGRAMME

- All new personnel (newly employed staff, national service personnel, interns, students undertaking their project/research work) at the facility, must take the course before they are allowed to work in the laboratories within the facility.
- To be authorized to work within the facility, it is required to pass a test after taking the course.
- For existing personnel of the facility, a refresher course on radiation protection and safety in the form described above is organized for them at least once every two years.
- As and when it is necessary and applicable, the services of the Radiation Protection Institute are sought during these training courses.

ACCESS CONTROL AND ZONING

- The reactor facility is divided into two basic sections with automated access control
  - supervised area
  - controlled area

- **Supervised Area:**
- An area where the radiation exposure received by a person working the whole year is below 0.3 of the annual dose limit (10 mSv).

- **Controlled area:**
- An area in which the radiation exposure received by a person working the whole year may exceed 0.3 of the annual dose limit or the area contains equipment of vital importance to the safety of the reactor and associated equipment.

RADIATION MONITORS

- The reactor complex incorporates 4 radiation monitors with readout on the control console.
- They are located in the reactor hall, on top of the reactor vessel, in the water purification room and the rabbit terminal room (attached to the reactor water purification resin column) and the sample transfer room (sample reception point of rabbit system A).
- The sensors are halogen GM tubes. The range is from 0 to 9999 μGy/hr.
- The monitors are linked to an alarm at the control console.
- During accident conditions, gamma and neutron survey meters will be used.

AUDITS AND REVIEWS

- A review of the RP programme based on design and operational activities is conducted.
- The following are considered as part of the review programme:
  - ✓ Timely review of major activities by RPO to verify that planning was sufficient.
  - ✓ Review of occupational exposures. So far, there have been no individual exposures greater than those established.
  - ✓ Periodic review and audit of the RP programme by the RadSC.
  - ✓ Periodic assessments by management of the effectiveness of the RP programme to institute possible changes and improvements in order to reduce overall exposures and releases.

RECORDS AND REPORTS

- To ensure reliability and effectiveness of the RP programme the following records are maintained:
  - ✓ The effective dose for the personnel who have worked at the Centre;
  - ✓ Radioactive material inventory, transfer and disposal;
  - ✓ Radiation survey results;
  - ✓ Radioactive effluent results;
  - ✓ Surface contamination survey results;
  - ✓ Environmental monitoring results;
  - ✓ Instrument calibration results;
  - ✓ Protection system quality assurance, e.g. interlock and warning systems checks;
  - ✓ Waste disposal.

RECORDS AND REPORTS

- The records will be maintained for the lifetime of the facility.
- At decommissioning, a decision will be made with the NRA concerning the ultimate repository for these records.
- The RadSC through the Director of NNRI will make the following reports to the NNRI Board:
  - ✓ Average personnel dose (year);
  - ✓ Maximum collective effective dose attained within a year in man-sieverts;
  - ✓ Amount of liquid and gaseous releases;
  - ✓ Quantities of solid waste;
  - ✓ Audit results.

RADIOACTIVE WASTE MANAGEMENT

RADIOACTIVE WASTE MANAGEMENT

- The operation of GHARR-1 normally does not generate radioactive waste of concern.
- However, the very low level waste that is generated covers
  - ✓ Solid waste
  - ✓ Liquid waste
  - ✓ Gaseous waste

RADIOACTIVE WASTE MANAGEMENT

- **SOLID RADIOACTIVE WASTES**
- They are collected into specially marked container and stored
- Waste consists of used poly-ethylene vials, gloves, glassware, cotton wool, irradiated samples
- A record is kept of the materials and the radioactivity of the materials placed in the container.
- Only β- and γ-emitting materials are placed in the containers such that the surface dose rate of the container does not exceed 30 μSv/hr.
- Waste containers are stored until transferred to the National Radioactive Waste Management Facility.

RADIOACTIVE WASTE MANAGEMENT

- **LIQUID WASTE:**
- Reactor vessel water and pool water are in closed loops and are not normally discharged

- If discharge of some of the water becomes necessary, it is discharged to a liquid waste storage tank.

- Before release to the sewer system, radioactive contents of the liquid in the tank is measured and only discharged if within the acceptable levels and approved by the Regulatory Body.

RADIOACTIVE WASTE MANAGEMENT

- **GASEOUS WASTE**
- Main sources of gaseous effluents are:
  - ✓ Activation of the air in the irradiated tubes
  - ✓ Activation of air dissolved in the reactor water
  - ✓ A small amount of volatile fission products caused by trapped uranium

- Gas is discharged weekly during reactor purged process. Main gas is Ar-41.

- The weekly purging ensures that the hydrogen gas formed by radiolytic decomposition of water is removed from the reactor vessel before it reaches explosive levels.

CONCLUSIONS

- The RP programme and radioactive waste management of the GHARR-1 has ensured that:
  - the use of radiation complies with relevant legislation and with approved codes of practice issued by Ghana Nuclear Regulatory Authority (NRA), International Atomic Energy Agency (IAEA) and other statutory bodies.
  - the radiation dose to staff and members of the public is kept as low as reasonably practicable.
  - sources of ionising radiation are held securely in accordance with current authorizations.
  - releases of radioactive materials to the environment are properly controlled

Thank You For Your Attention
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