Implementation of the Borehole Disposal Concept in Ghana-Status

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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- Ghana Atomic Energy Commission (GAEC) was established by an Act of Parliament (Act 204) in 1963 which has been superseded by Act 588 in 2000.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 main functions of the Commission include the promotion and development of peaceful application of nuclear techniques for the benefit of Ghana.

- In pursuance of the above objective GAEC established four institutes under which the functions are carried out

Regulatory Framework

- The Radiation Protection Board (RPB) was established in 1993 by the legislative instrument LI 1559 as the National Regulatory Authority in Ghana.
- It has the mandate to

✓ license,

✓ register,

✓ authorize and

✓ inspect radiation sources and facilities

- The RPB also enforces codes of practice for the purposes of radiation safety in Ghana.
- A new Legisiative Instrument is receiving Government attention to establish an Independent National Nuclear Regulatory Authority

Radioactive Waste Management Infrastructure

- The National Radioactive Waste Management Centre (NRWMC), was established in July 1995.

- The functions of the NRWMC include:

✓ Management of radioactive waste generated in Ghana

✓ Establishment of facilities for management of radioactive waste

✓ Research activities to safely manage radioactive waste generated in Ghana.

Radioactive Waste Management Facility

- A new Centralized Waste Storage facility has been constructed with assistance from the United States Department of Energy (GTRI Program) and the IAEA,
- The storage facility has
  - an area for receipt of the waste,
  - low activity/decay storage unit and
  - high activity waste storage unit

- The facility is equipped with physical protection systems that renders the stored waste materials safe and secured against intrusion, sabotage or theft.

- **A Centralized Waste Processing facility is currently under refurbishment. It will have an**

- **Office accommodation and laboratory**
- **Unit for segregation of the waste materials,**
- **Unit for conditioning of non-compatible waste and disused sources**
- **Treatment of liquid waste.**

Central Waste Processing and Storage facility

Radioactive Waste Management Practice

- The radioactive waste management system practiced in Ghana is storage which requires resources and long term commitment.

- Most of the waste in storage are legacy waste and in the form of sealed sources which are not covered by Return to Supplier agreement so they have to be managed in Ghana

- Due to financial constraints, some Cat 1 and 2 disused sealed sources which were to be returned to the supplier/manufacturer could not be returned.

Borehole Disposal Project

- Due to the half-life of the radionuclides and threat to national security, storage is considered as not a sustainable option for management of DSRS

- Hence the need for a disposal facility.

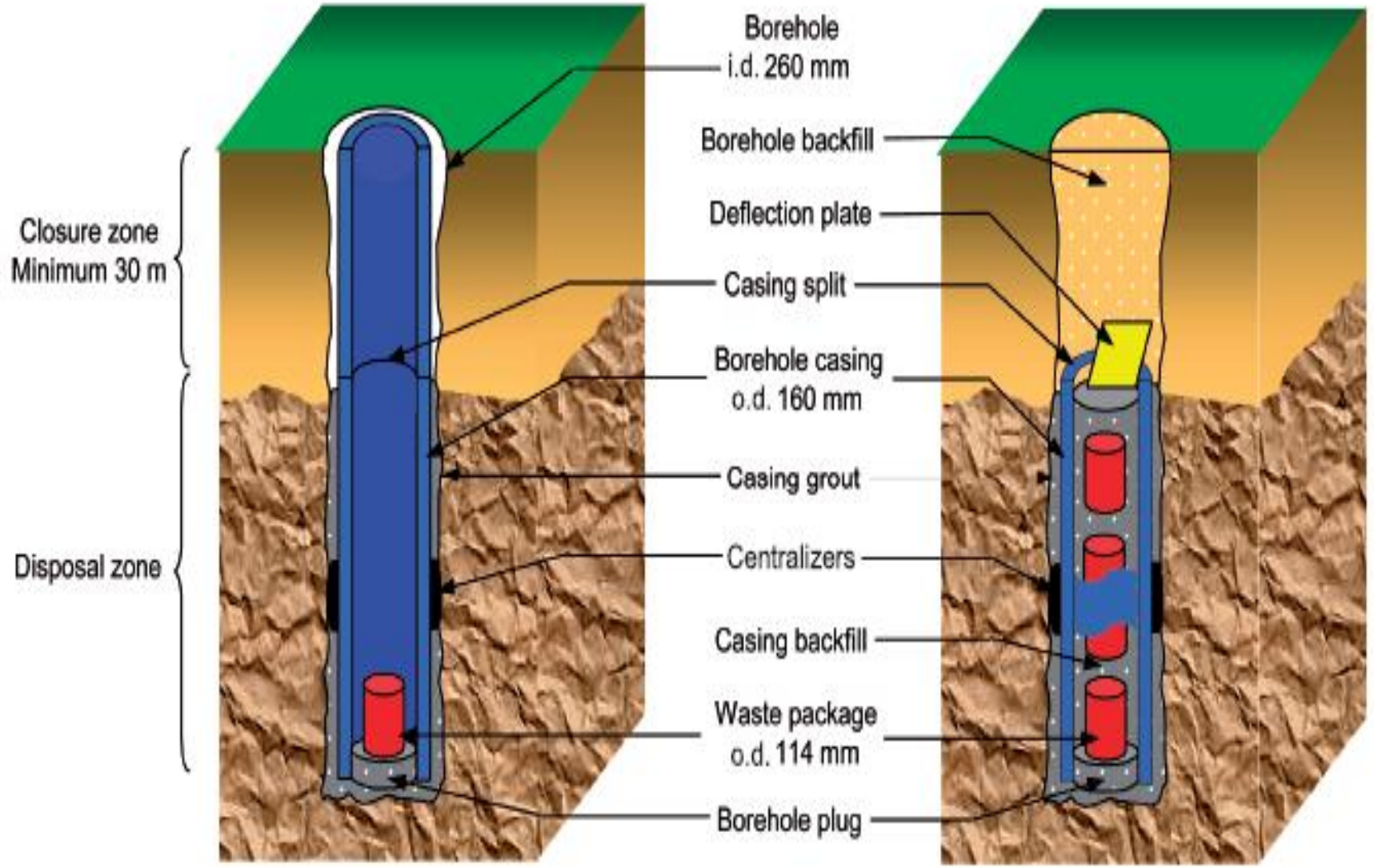
- Considering the small waste volumes of Ghana, there is the need for:
  - small volume repository
  - simple but safe technology with
  - economically viable concept

- In 2006 the Ghana expressed the willingness to exploit the Borehole Disposal Concept developed in South Africa under the IAEA TC Project for disposal of the disused sealed sources

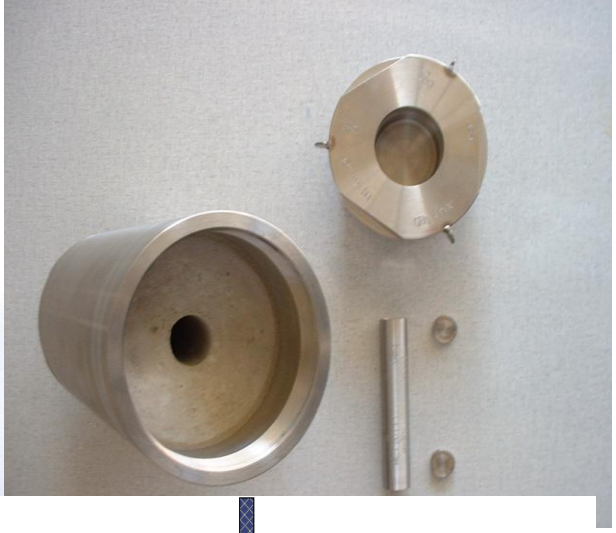
Borehole Disposal Concept (BDC)

- A group of scientists from
  - National Nuclear Research Institute (NNRI) of GAEC,
  - Ghana Geological Survey Department,
  - Ghana Hydrological Services and the
  - Water Research Institute
- to study the BDC and characterize a site for its implementation in Ghana.

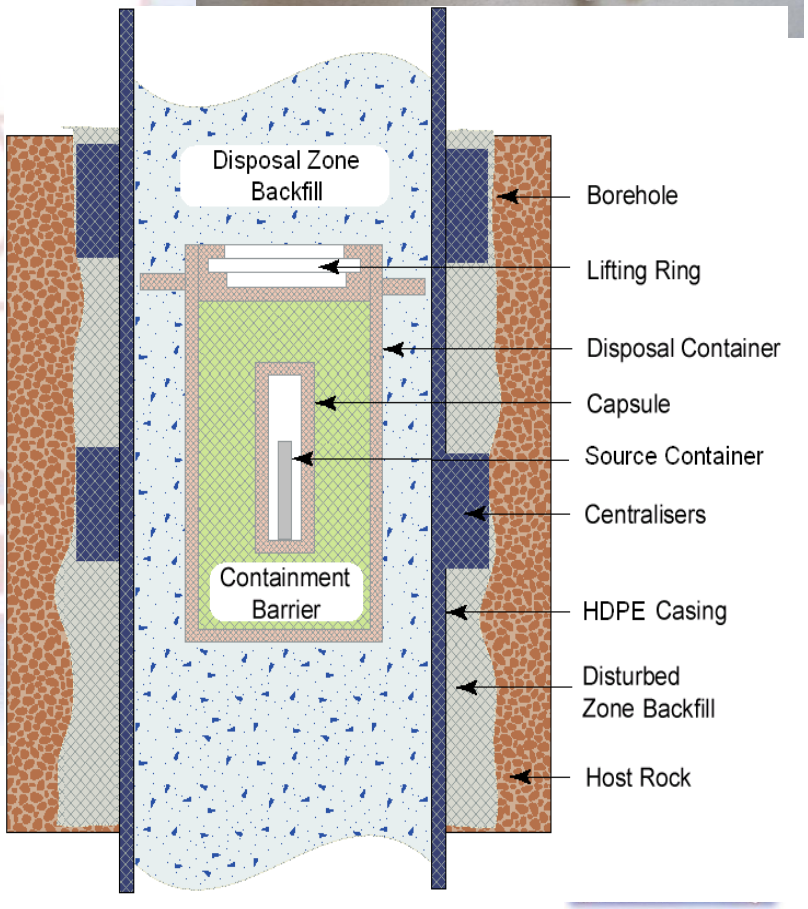
Borehole Disposal Concept



Reference Design



- Waste Packages
  - Source container
  - Capsule (stainless steel Type 316 L) (3 mm thick, Ø 21 mm)
  - Containment barrier (cement grout) (41 mm thick)
  - Disposal container (stainless steel Type 316 L) (6 mm thick, Ø 115 mm)



PROJECT PLAN FOR BDC - Phase 1

- **Objective:** To identify and completely characterise a site for implementation of the Borehole Disposal Facility in Ghana.

- **Outcome:** Complete documentation on site characteristics

- **Duration**: 2009 - 2011

- **Activities**

- Review of existing document /information
- Geophysical Investigation and preliminary site characterization
- Updating waste inventory (software-RWMR)
- Review of National Radioactive Waste Management regulation to include regulation on waste disposal
- Draft Radioactive Waste Management Policy and Strategy
- Draft technical specification and contract document for site investigation
- Development of Project Management System
- Preliminary Safety Assessment for the Borehole Disposal Concept in Ghana

Geophysical investigations

- Geophysical investigation (Seismic Refraction and electrical resistivity studies) of the area was carried out;
- The results of their investigation indicated that;
  - ✓ The bedrock has high compressional and shear velocities
  - ✓ True resistivity of bedrock suggested that the bedrock is probably gneissic or granitic rocks
  - ✓ Suggest that the bedrock rock at the site is competent and could serve the purpose
  - ✓ Drilling must be carried out at where true high resistivity has been calculated for detailed geological investigation.

Safety Assessment for Borehole Disposal of Disused Sealed Sources in Ghana

- To produce the first iteration of a safety assessment that can be used in the development of a suitable borehole disposal facility (BDF) for Ghana taking into account the inventory to be disposed and the site characteristics.

- To identify the key parameters that needs to be characterised at the proposed site.

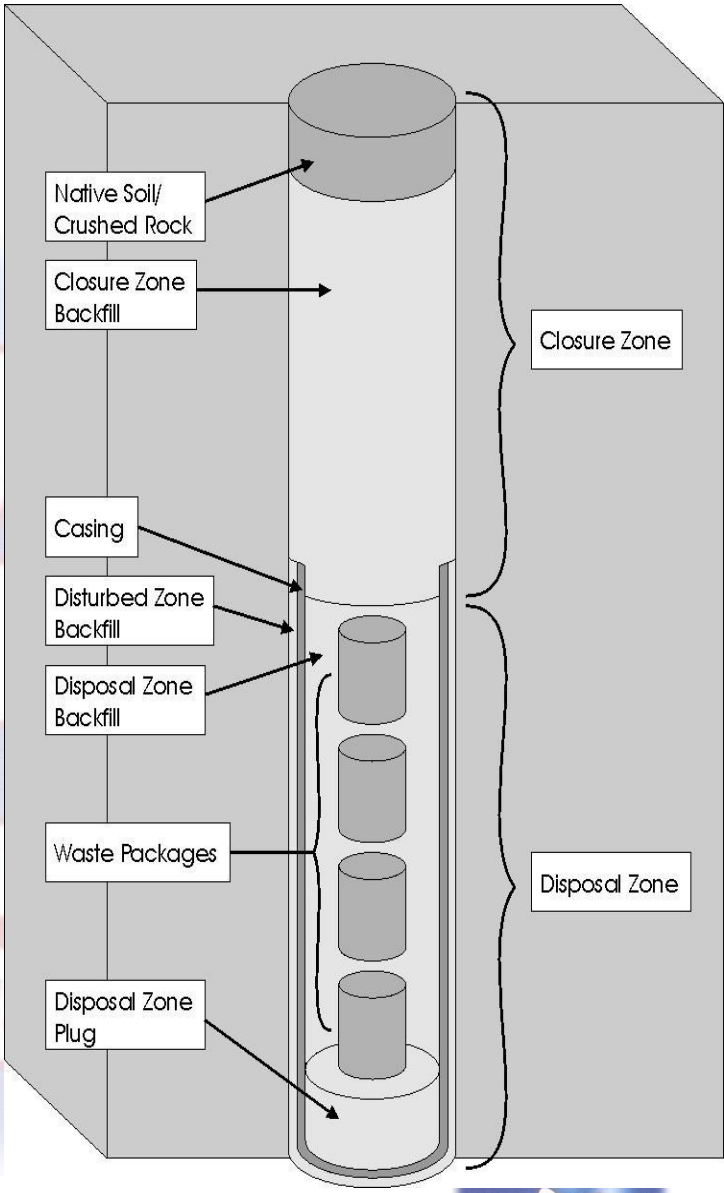
- To demonstrate and build confidence in the use of narrow diameter boreholes as a safe disposal concept for disused radioactive sources

- **The SA used data on the regional geology, hydrogeology and geochemical conditions and extrapolate to the site.**

- **Preliminary Screening used spreadsheet to calculate dose from direct exposure from ingestion, inhalation and external irradiation to a single disused source**
- **The screening calculations indicated that the P-32, Ca-45, Fe-59, Sr-89, and Ir-192 sources can all be decay stored and do not need to be considered for disposal in the BDF.**

- **Radionuclides considered are Co-60, Sr-90, Cs-137, Ra-226, Am-241 and Cf-252**

- **Unit inventory of 1 TBq per package**
- **43 waste packages will be disposed,**
- **One borehole considered**
- **The total thickness of the disposal zone is 43.5 m.**
- **The total depth of the closure zone is 56.5m,**



- **An individual effective dose constraint of 0.3 $mSvy^{-1}$ for adult members of the public for all potential future exposures**

- **The AMBER software tool was used to implement the assessment model**

- **TypeGeosphere – 'Aerobic Fractured', 'Aerobic Porous', 'Anaerobic Fractured', and 'AnaerobicPorous' to account for uncertainty in the nature of the oxidising/reducing conditions and the geosphere flow**

Assessment Timeframes

Activity	Timeframe
Borehole Construction and Waste Emplacement	About one year
Site Closure	Immediately following the waste disposal operation
Institutional Controls Period (e.g. surveillance, local/national government records, planning authority restrictions, site marked on official maps)	50 years
Control no longer effective	50,years

SA Conclusions

- **The assessment indicates that Ghana's current inventory of disused sealed sources appear to be capable of being safely disposed using the borehole disposal concept.**
  - ✓ **An alternative disposal option needs to be found for the liquid H-3 waste**
  - ✓ **Further characterisation is required of the sources and geosphere.**

- **Geosphere characterisation – two boreholes drilled to obtain data on the nature of groundwater flows (fracture vs porous), the hydraulic parameters (hydraulic conductivity, gradient, porosity), salinity and Eh conditions.**

Project Plan For BDC - Phase 2

- **Objective:** To carry out site specific safety and develop a safety case for implementation of the Borehole Disposal facility in Ghana

- **Outcome:** Documentation to demonstrate and build confidence in implementation of the Borehole Disposal facility in Ghana

- **Duration**: 2012 - 2013

Phase 2 - Activities:

- Detailed site characterization-geology(drilling boreholes, etc), geochemistry, hydrogeology
- Perform site specific safety assessment studies
- Development of safety case
- Development of the engineered design of the facility including waste package components

CONCLUSION

- A Sound Radioactive Waste Management infrastructure is been established
- IAEA -AFRA Projects played major role in the development of the Waste Management Infrastructure especially in the Borehole Disposal concept
- Assistance from the US DOE under the GTRI program has been very instrumental


Thanks for your attention