

# Borehole Disposal of Spent Sources (BOSS)

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# BOSS Program

IAEA program to address disposition of spent sources in Member States

Initiated in 1990s

Developed primarily by the Nuclear Energy Corporation of South Africa (Necsa)

Numerous consultant meetings, analyses, and documents

Now approaching field implementation

This presentation is my independent perspective on interesting parts of the program

# The Problem

Spent sources are poorly controlled or uncontrolled in numerous countries

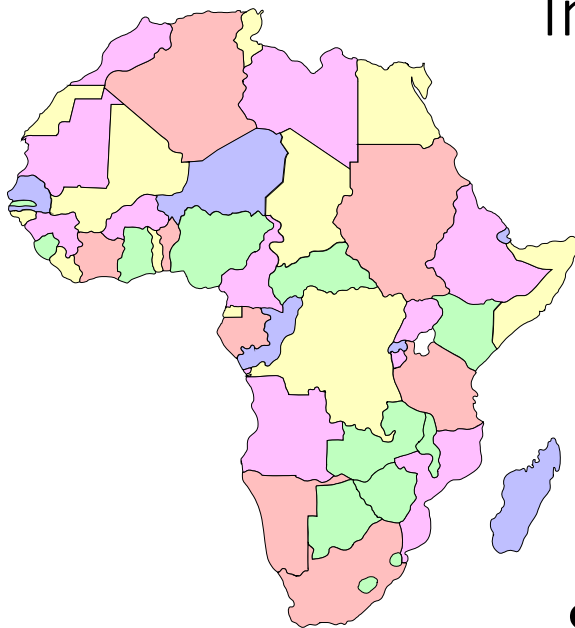
Spent sources pose a potential security risk

Many countries have little or no infrastructure for addressing the problem

For many countries this is the only radioactive waste problem

Many sources are in poor countries with higher priorities

# Project Foundations



Initiated 1995 at a TC-AFRA  
Regional Training Course  
hosted by NECSA

Uncontrolled Storage  
vs.

Safe & Secure disposal



Disposal  
solution

# Typical inventories

High activity concentrations (“inappropriate” for near-surface disposal)

Mostly short to moderate half life radionuclides

*Co-60*

*Cs-137*

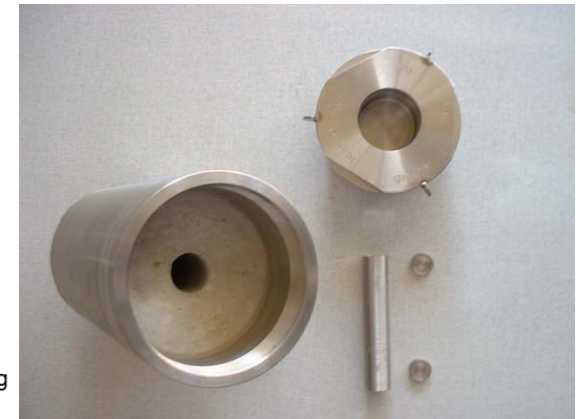
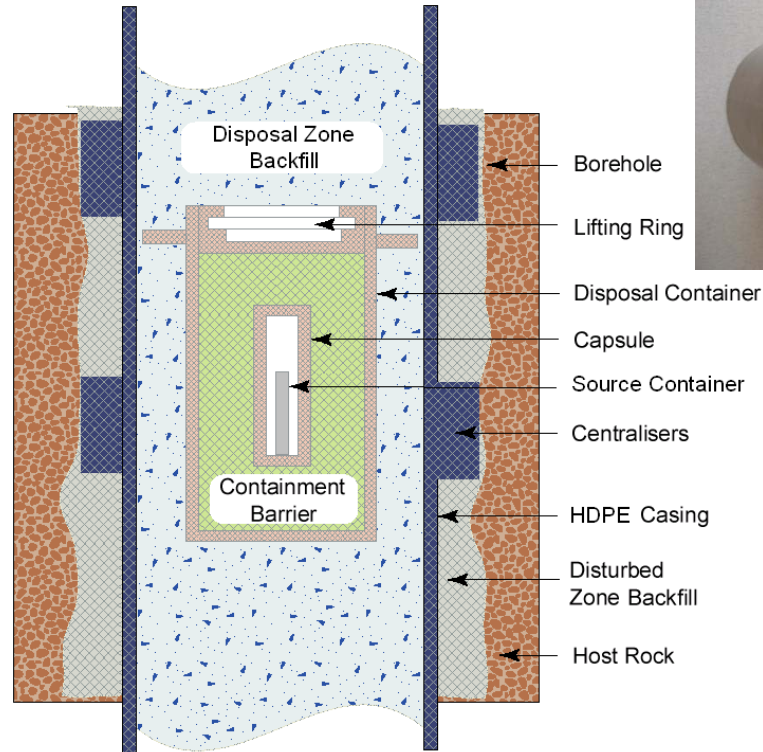
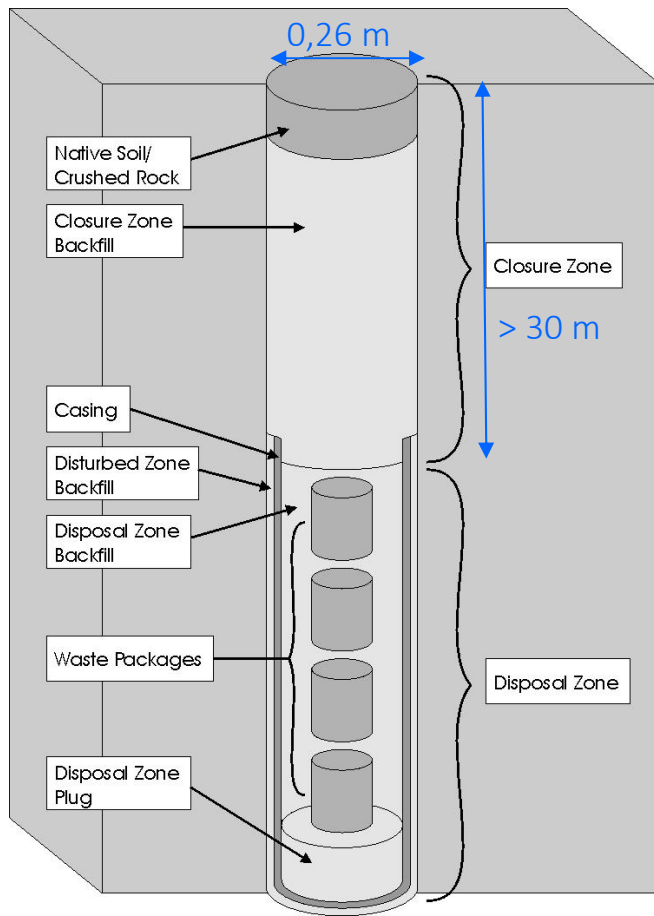
*Sr-90*

Some notable exceptions

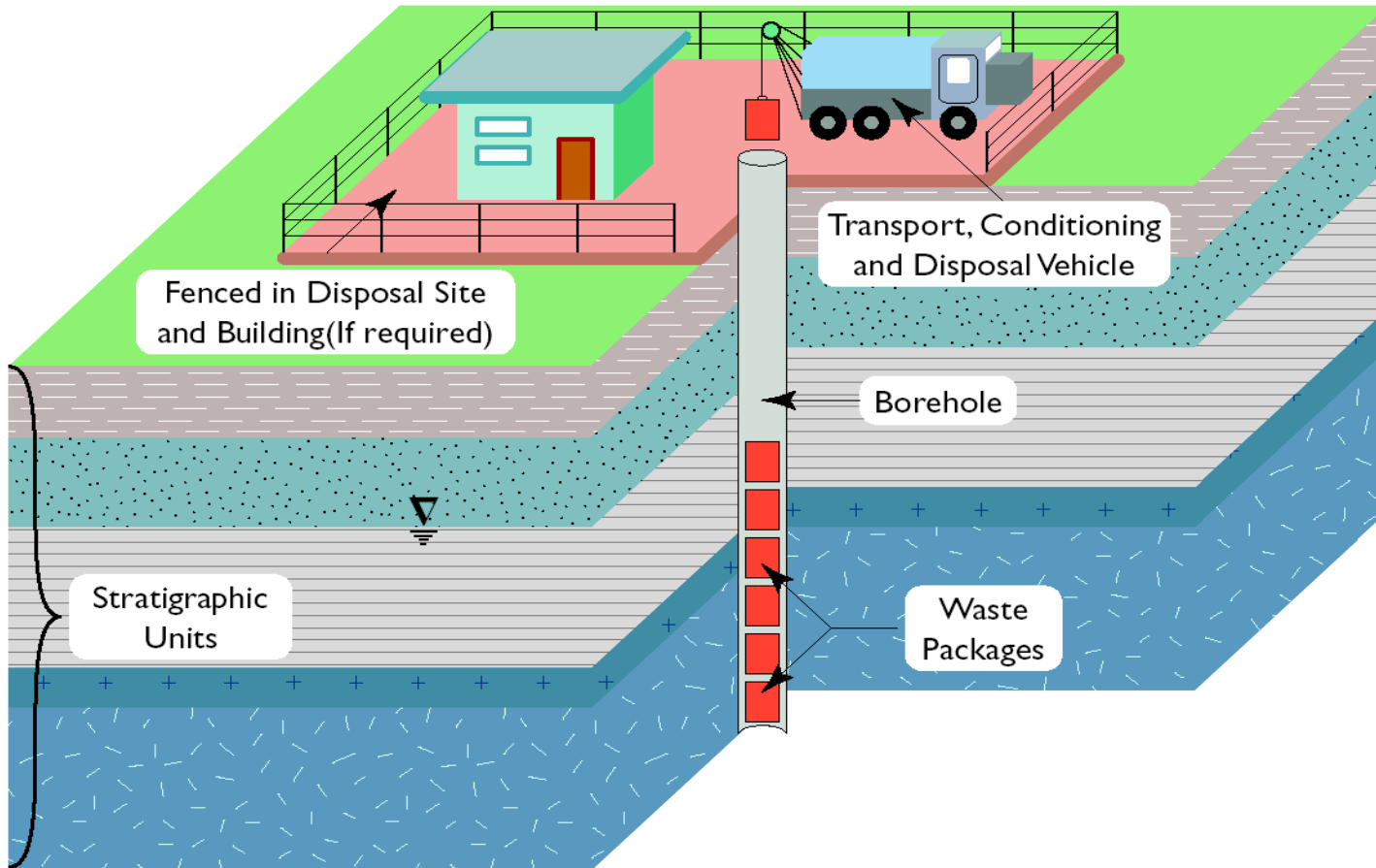
*Ra-226 (e.g. brachytherapy needles)*

*Pu-239 (Former Soviet Union)*

# BOSS Disposal Concept

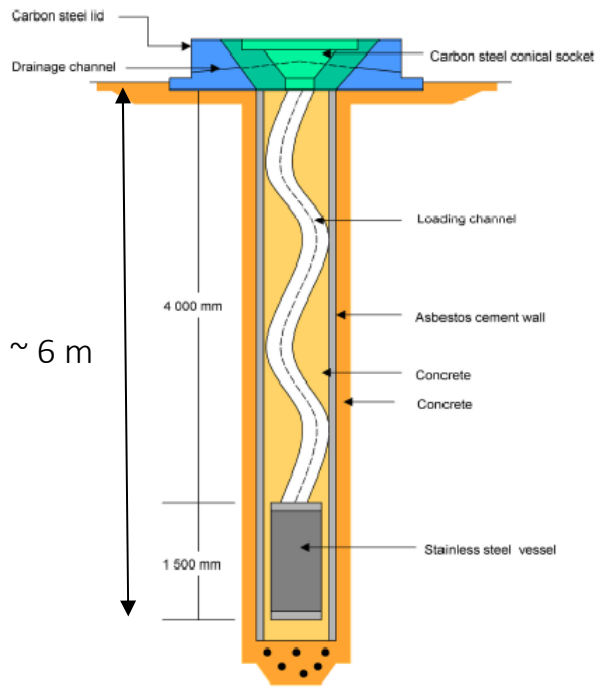


# BOSS system

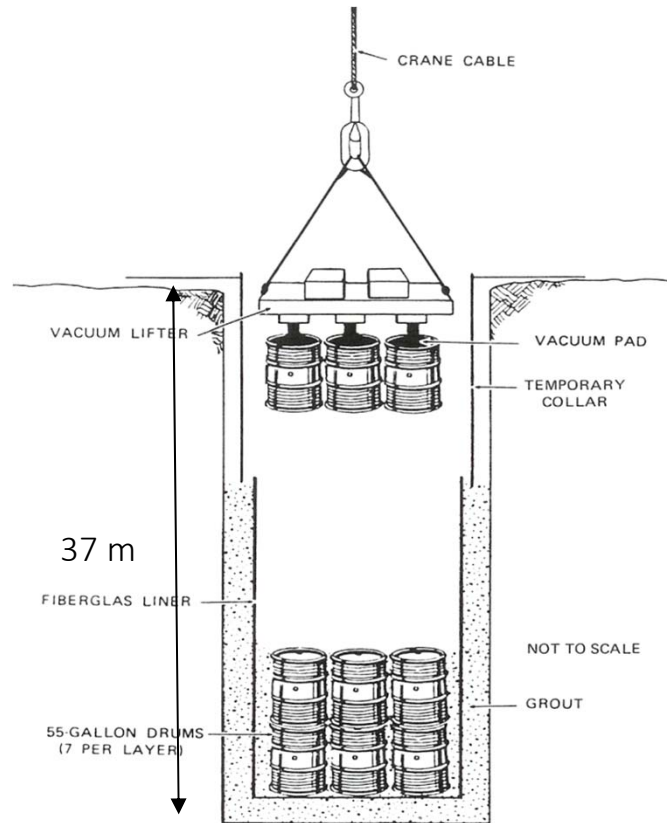


Includes mobile surface facilities, equipment, and components for full chain of operations.

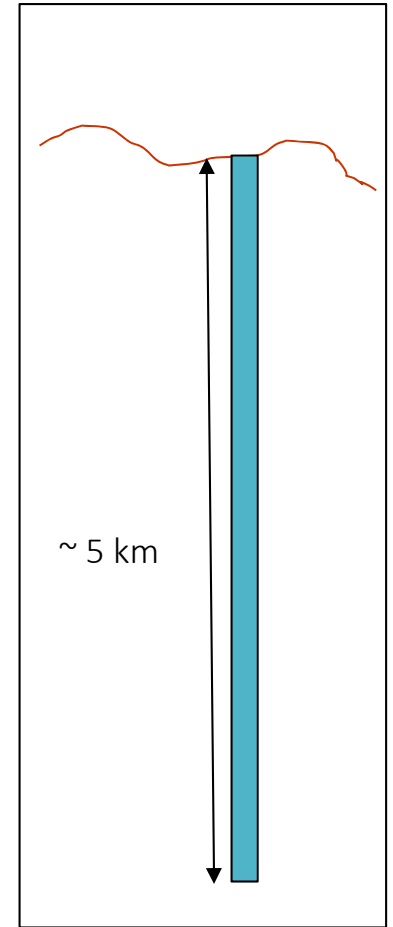
# BOSS Disposal System – What it is not



“RADON” Boreholes



“Greater Confinement Disposal”



“Deep Borehole”



# Fundamental considerations

Safe implementation with limited resources

Broad range of suitable (safe) site properties

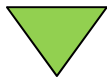
Suitable for a typical national inventory

Availability of qualified components / equipment



# Brief history: 1996 - 2005

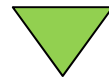
1996



Phase I

Typical inventories  
Concept description  
Illustrative sites

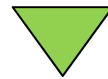
1999



Phase II

Concept evaluation  
Preliminary SA

2001



Phase III

Detailed design  
Technical feasibility  
Generic SA  
WAC Guidelines

IAEA-TECDOC-1368

*Safety considerations in the disposal of disused sealed radioactive sources in borehole facilities*

2005



WATRP  
Intl. Peer Review

Range of sites  
Range of inventories  
316L stainless steel  
Chain of operations  
Inform  
Describe  
Implement

2005

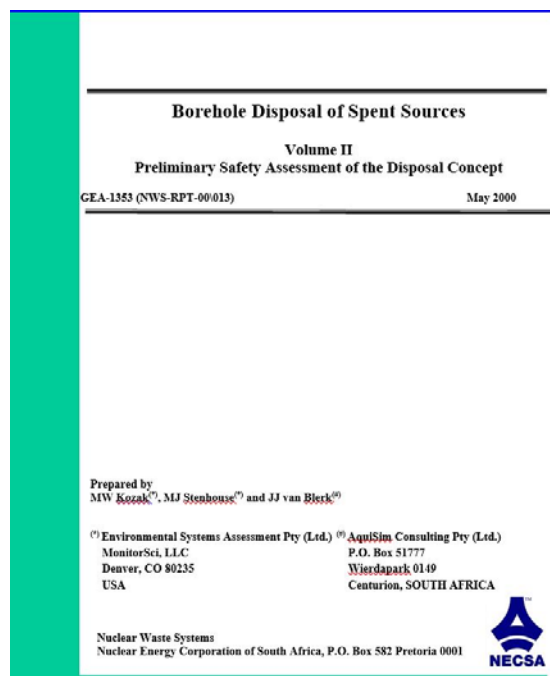


Phase IV

2015



Phase V



INTERNATIONAL ATOMIC ENERGY AGENCY



August 2003



# Issues in Implementing a National Framework

National legal and regulatory framework is likely to be absent

Performance-based regulatory frameworks are labor intensive and require a high level of skill

Skilled practitioners needed for both implementation and regulation

Use of internationally based subcontractors does not fully address the staffing issue

For many countries, there is no broader need for radioactive waste management

# Issues in implementing a safety strategy

Normal practice in radioactive waste management is the use of multiple and redundant barriers

To take proper account of the geological setting, site characterization is needed – expensive

*What is the minimum site characterization needed to assure long-term safety?*

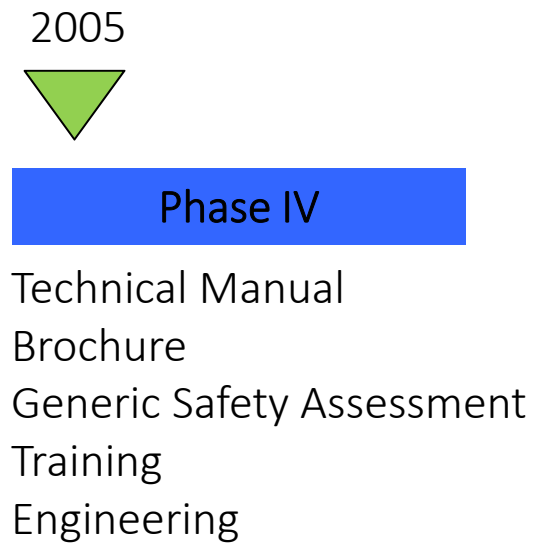
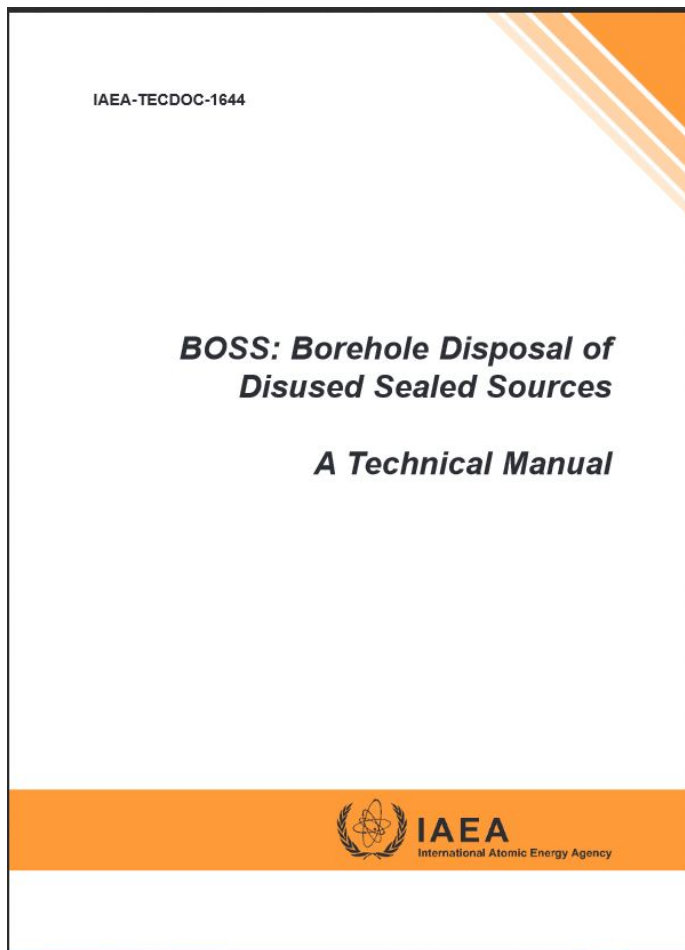
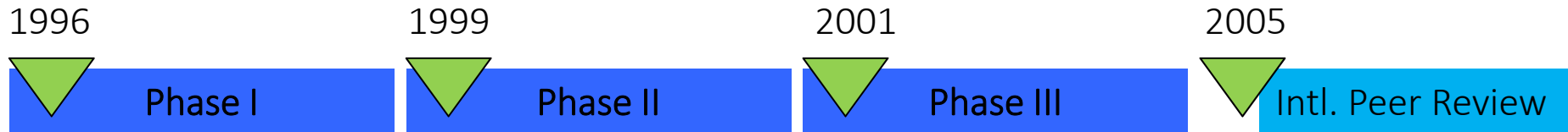
*Is it possible to rely heavily (or even exclusively) on engineered barriers?*

*Is it possible (or desirable) to rely on a generic safety assessment?*

*Can we identify key parameters in the site characterization that provide a passive environment for the waste package?*

The role of inadvertent intrusion

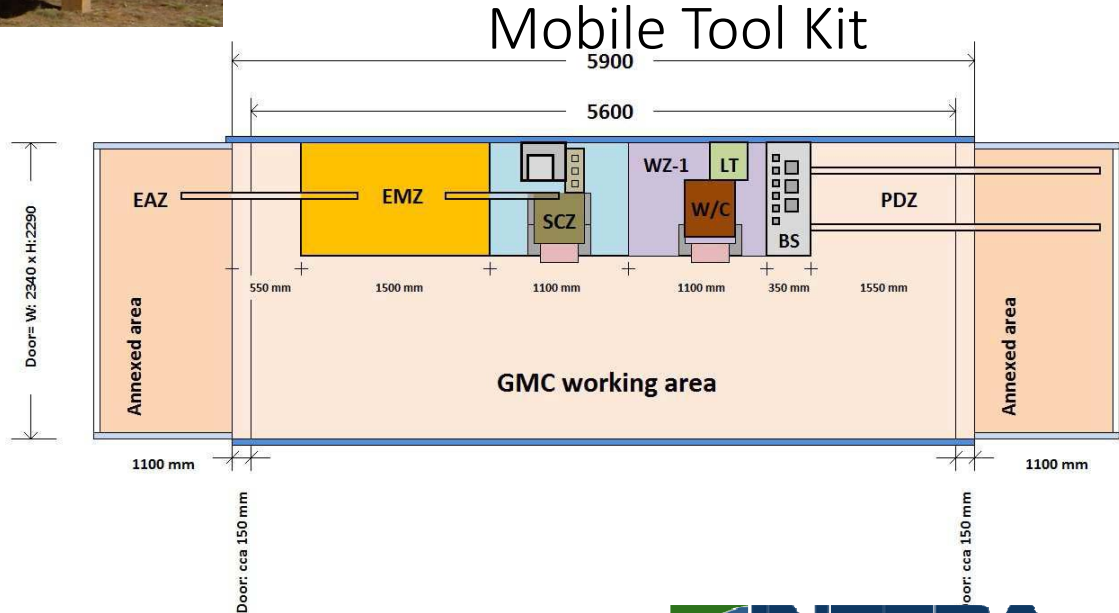
# Brief history: 2005 - 2015



# Emplacement – Laboratory Studies



# Conditioning facility

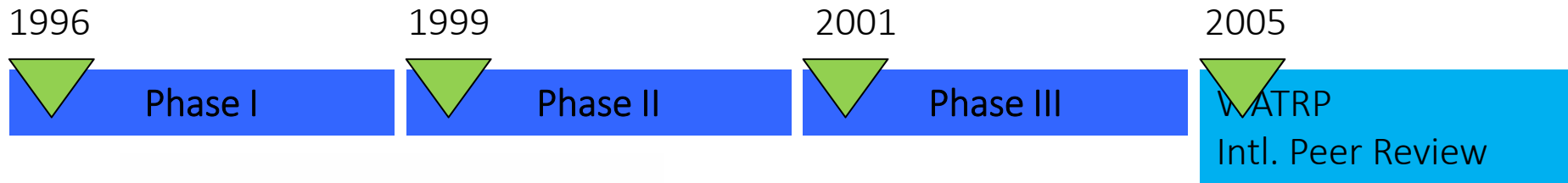




Peer Review before actual operations took place



# Outlook: 2015 - ...



## IAEA Safety Standards

for protecting people and the environment

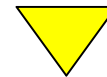
Borehole Disposal  
Facilities for Radioactive  
Waste

Safety Guide

No. SSG-1



2015



National implementation

Site-specific safety case

Licensing

Construction/Operation

# National Implementation

Malaysia – Ghana – Philippines -- Others?

Pilot projects in progress

Site specific safety cases

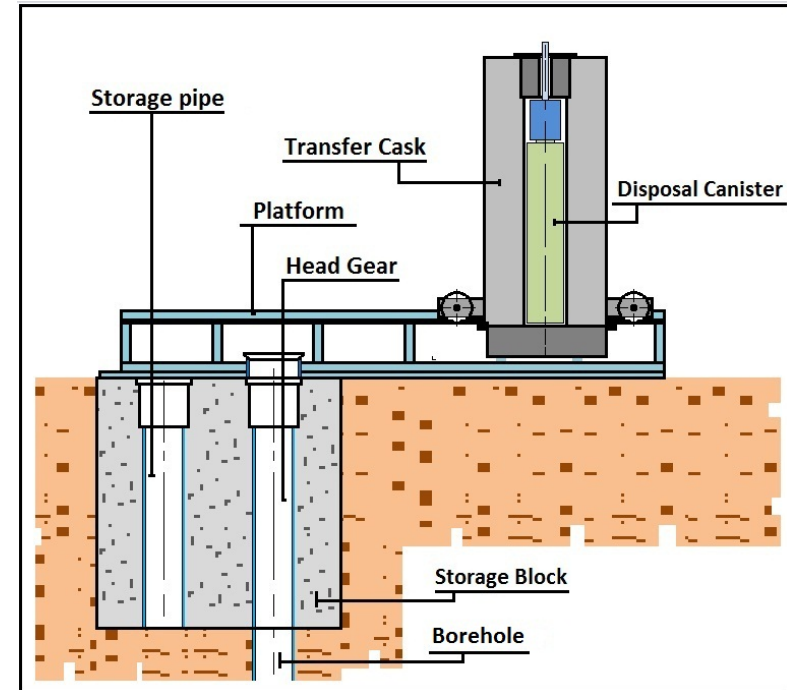
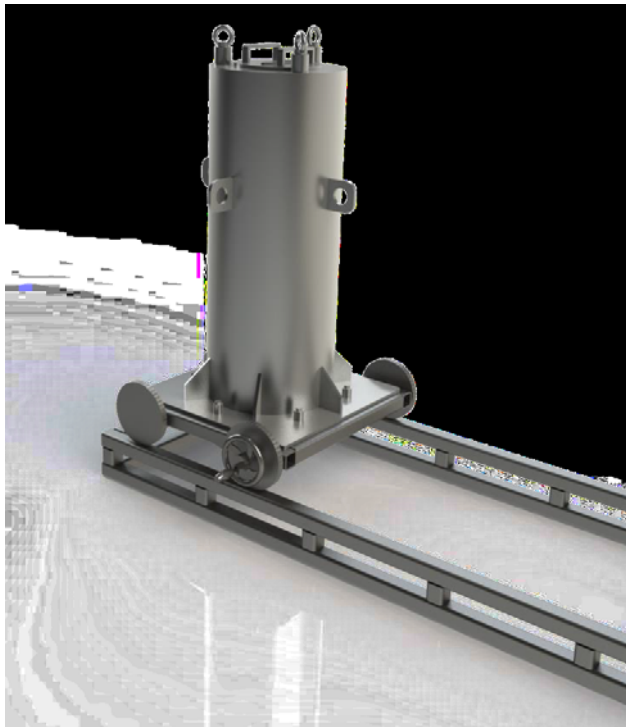
Qualified components and equipment

Licensing

## Implementation for low activity source disposal in borehole

Technique has been developed for low activity source disposal:

(Transfer Cask + Platform)



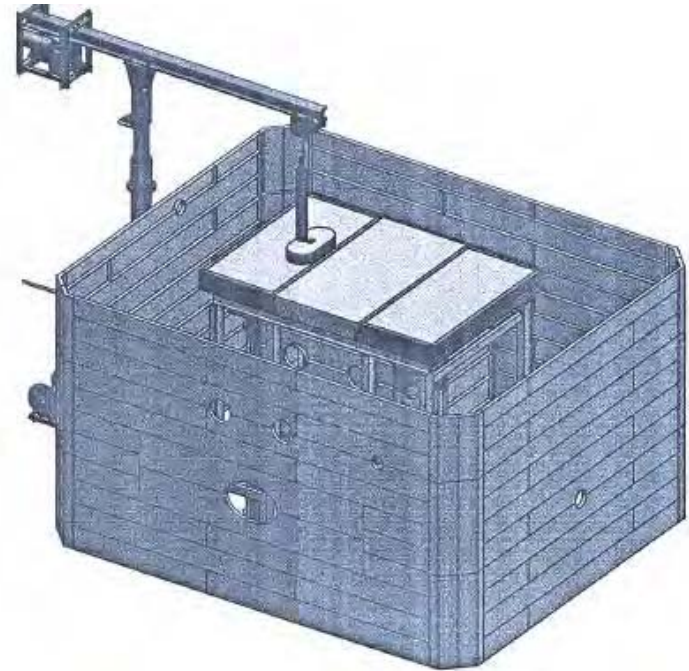
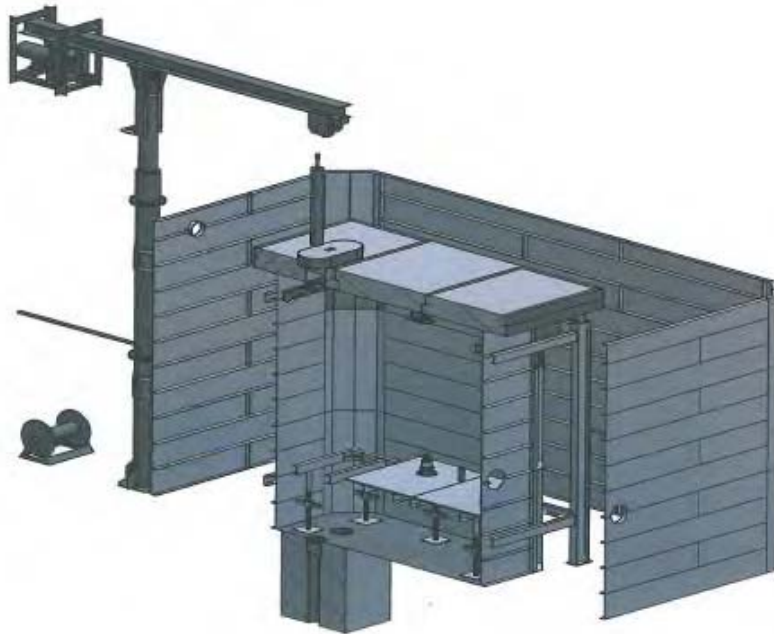
- Engineering design of these items are now available
- 2 Transfer Casks + Platform are currently manufactured and were tested in November 2015

# Implementation of the low activity source handling apparatus



## Improvements for high activity source disposal in borehole

Mobile Hot Cell has been improved allowing SHARS disposal in a borehole:



Further work to do:

- Developing welding technology and equipment for disposal container
- Testing the hardware through a test operation (demonstration)

# Summary: Main features of the *BOSS* system

Diameter adapted to water well drilling

Isolation from surface perturbation (depth; site properties)

Safe in either unsaturated or saturated formation

Safe in a broad range of site geochemical properties

Containment in engineered barrier system

- Capsule containing sources

- Buffer

- Container

- Cement backfill

Chain of operations: Encapsulation, testing, emplacement