OVERVIEW OF DISPOSAL OPTIONS FOR DSRS

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Waste Technology Section

Presentation to Code of Conduct Meeting

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International Atomic Energy Agency

The IAEA Supporting Safe and Secure Storage of DSRS

Thailand

Sudan

Tanzania

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Why Extended Storage is not a Sufficient Management Strategy

Not a sustainable option in the long-term

- On-going financial liabilities
- Poor or no regulatory control in certain countries
- Limited expertise for managing sources
- Institutional and social stability

→ Potential health and environmental hazard

→ Security concerns (potential for malicious use)

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DISPOSAL

Emplacement of *waste* in an appropriate facility without the intention of retrieval.

(From: IAEA Safety Glossary)

Note: In some Member States, the term *disposal* is used administratively in such a way as to include, for example, ……*the transfer of waste between operators.* Such transfers, including repatriation, are not in themselves a true end-point option.

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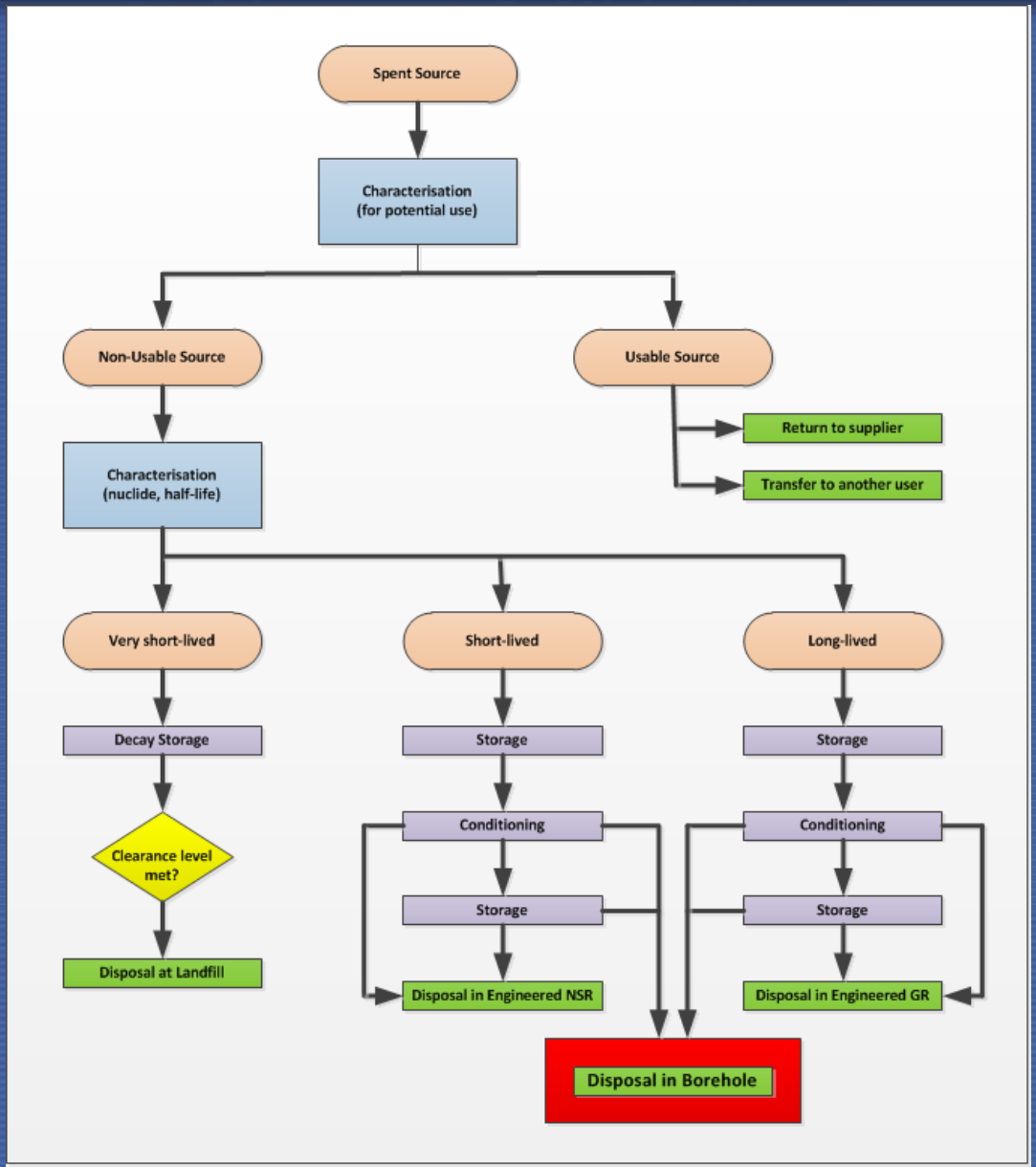
Disposal & Recycle/Re-use Options



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Broad Disposal Options

- Disposal at Landfill
- Near-surface Repository Disposal
  - (with and without engineered barriers) including underground cavities (natural or engineered) at relatively shallow depths
- Geological Repository Disposal
  - (a mined facility)
- Borehole Disposal

Co-disposal might be an option e.g. NSR & BDC

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TYPES OF DISPOSAL FACILITIES

Surface trenches (US Ecology Richland)

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TYPES OF DISPOSAL FACILITIES

Near surface engineered vaults (El Cabril, Spain)

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TYPES OF DISPOSAL FACILITIES

Geological repositories (Morsleben, Germany)

Waste Package Emplacement at Morsleben

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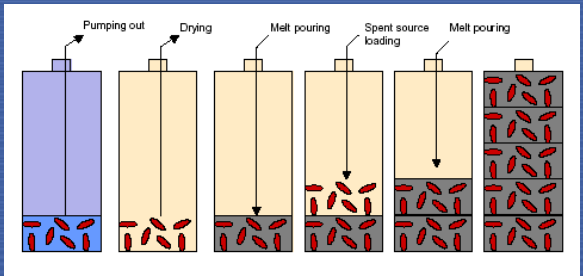
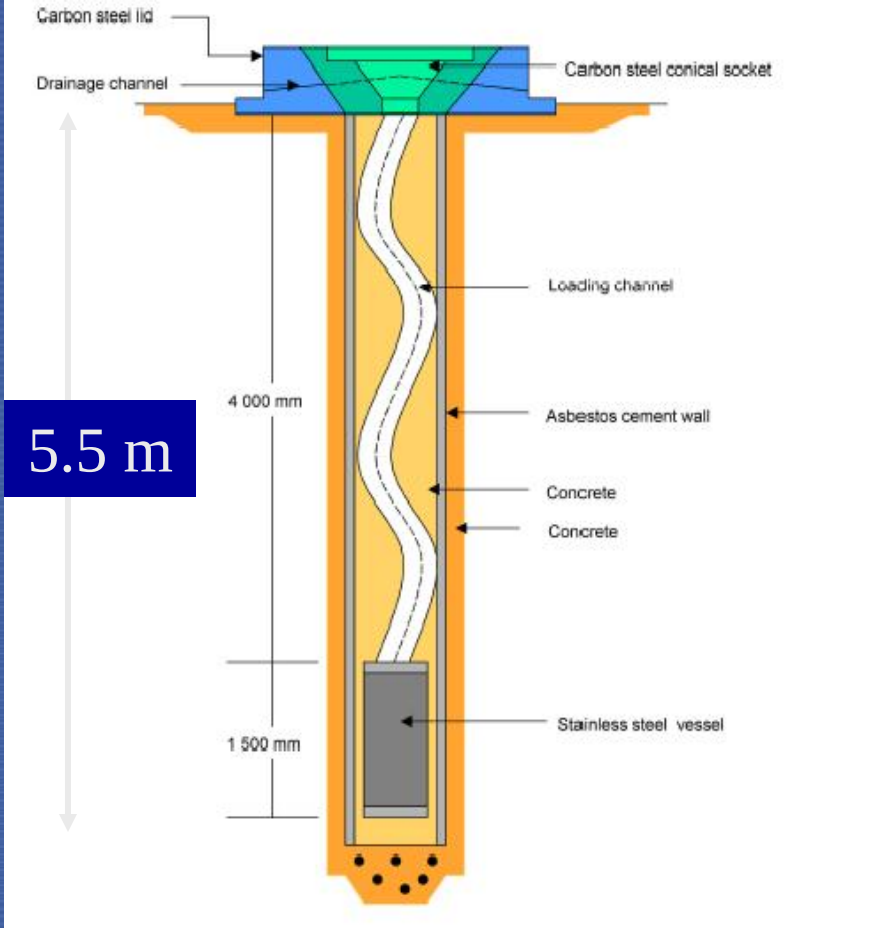
Existing borehole facilities

- RADON boreholes in former USSR
- Western Australia - Mt Walton
- USA - Greater Confinement Disposal

TYPES OF DISPOSAL FACILITIES

RADON Boreholes





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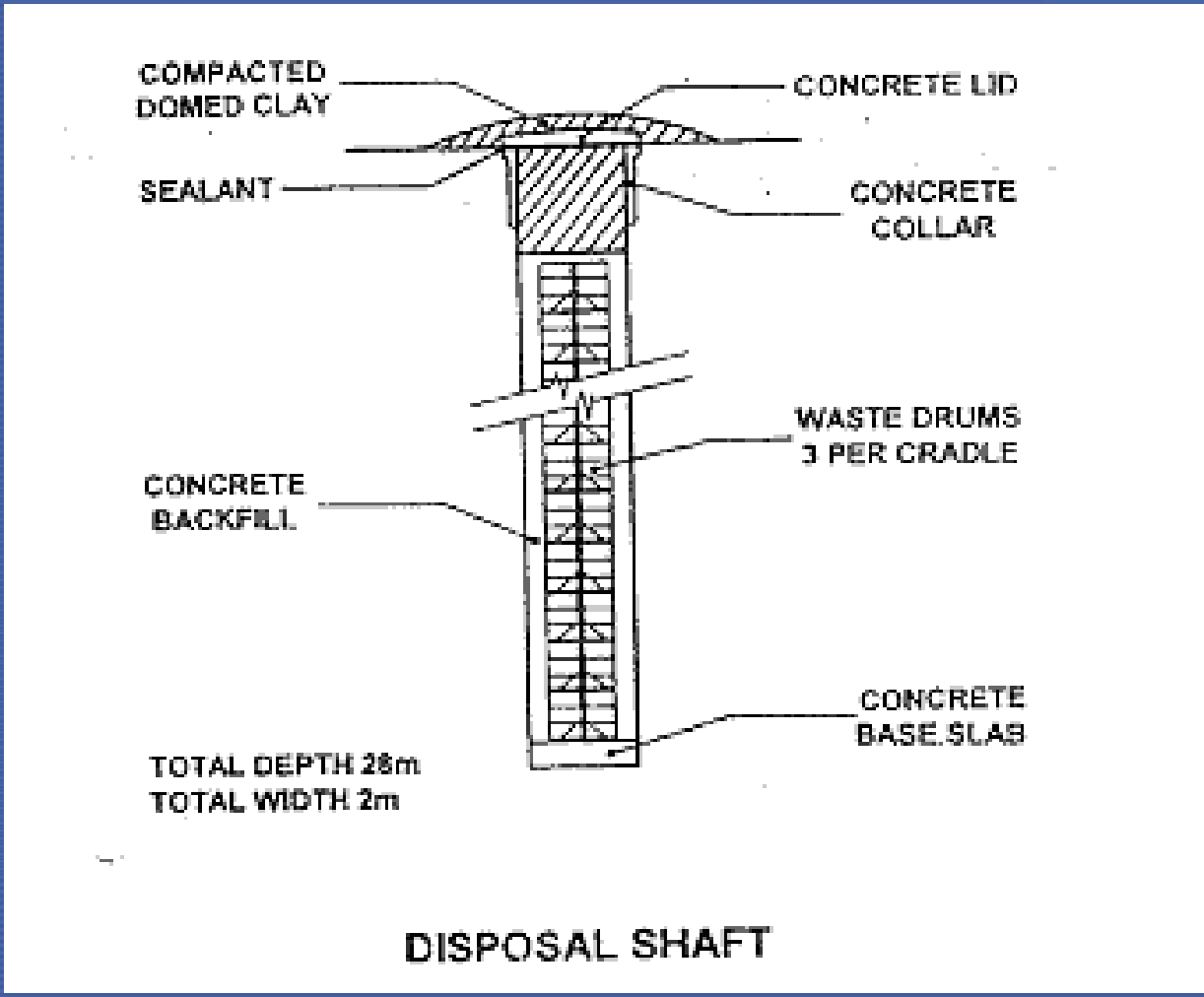
TYPES OF DISPOSAL FACILITIES

Australia:
Mt Walton
Intractable Waste
Facility



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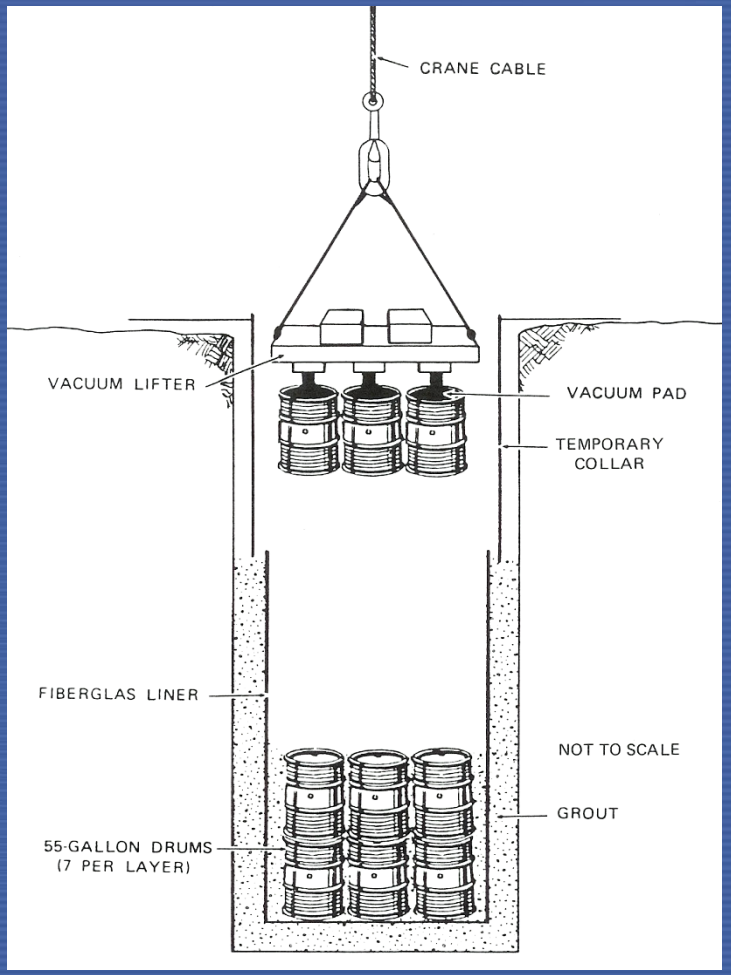
TYPES OF DISPOSAL FACILITIES

USA - Greater Confinement Nevada Test Site

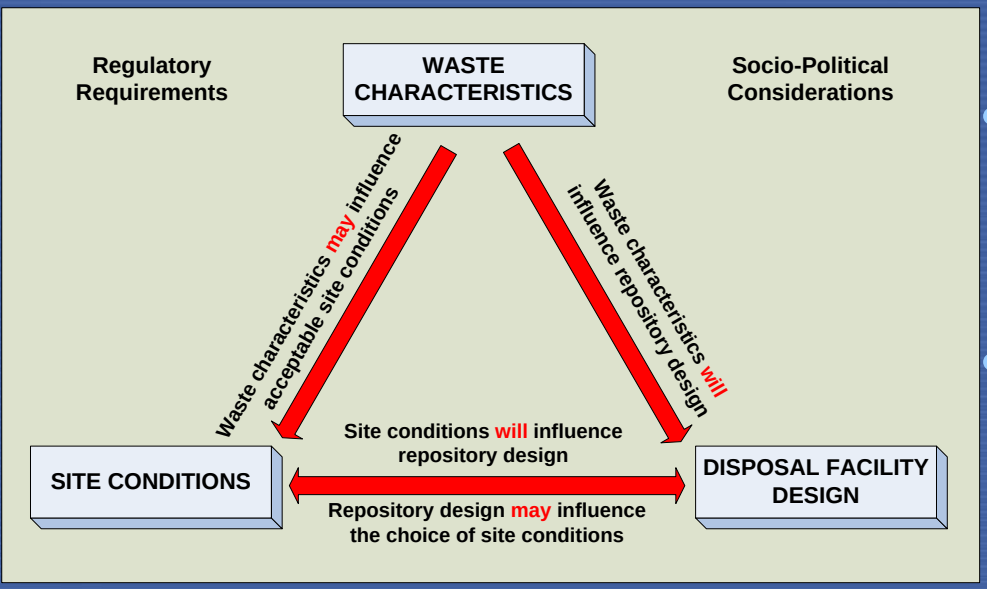


3 m diameter

37 m deep

21 m closure zone

Factors Affecting Choice of Disposal Option



- Nature of the waste (e.g. activity, half-life, toxicity)
- Quantity and location of waste (e.g. volume, where is it?)
- Site Characteristics (e.g. nature of the rock, water flow & chemistry, stability)
- Preferences concerning repository design and nature of engineered barriers
- Other Factors (e.g. national policy and strategy, availability of resources, stakeholder consensus)

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Graded Approach

- **A graded approach entails '***An application of safety requirements that is commensurate with the characteristics of the practice or source and with the magnitude and likelihood of the exposures'* (IAEA Safety Glossary)

Predisposal Resource Optimisation

- Simplified conditioning
- Less sophisticated container, if any
- Simple transportation/handling systems
- Reduction in workforce

Disposal Resource Optimisation

- Repository scale commensurate with inventory
- Adequate barrier system
- Simple disposal operations
- Short operational phase

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No Compromise on Safety

The IAEA BOSS System: BOrehole disposal of Sealed Sources

- **BOSS is a comprehensive system originally designed to provide for disposal of relatively small DSRS inventories in AFRA Member States**

- **The concept was developed in collaboration with Necsa of South Africa**

- **BOSS comprises three key components:**
  1. Source conditioning/storage/packaging
  2. Mobile hot cell for conditioning high activity DSRS
  3. Delayed or direct disposal in a generic borehole repository design to be adapted as required (Borehole Disposal Concept)

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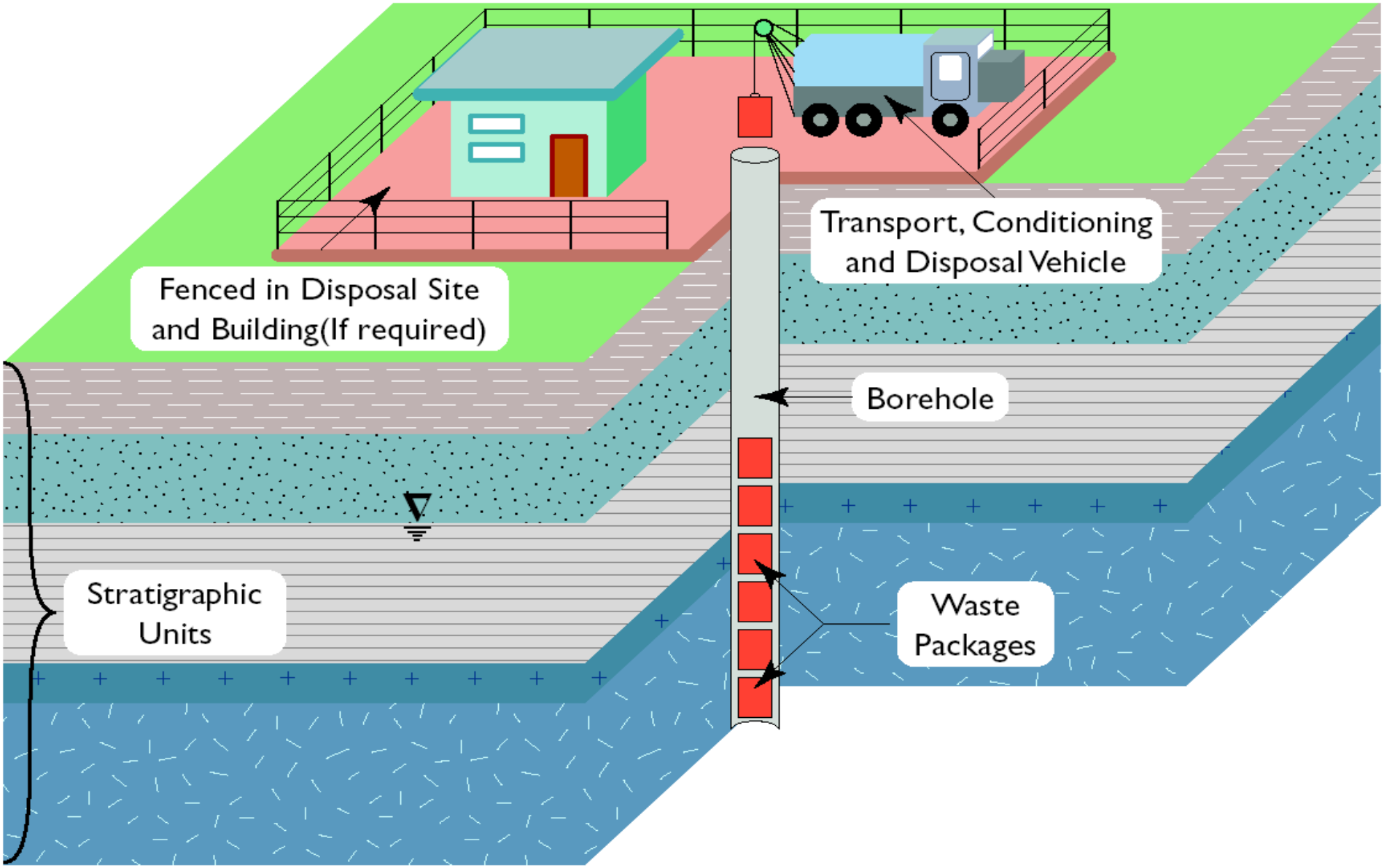
The BOSS Concept



Conditioning

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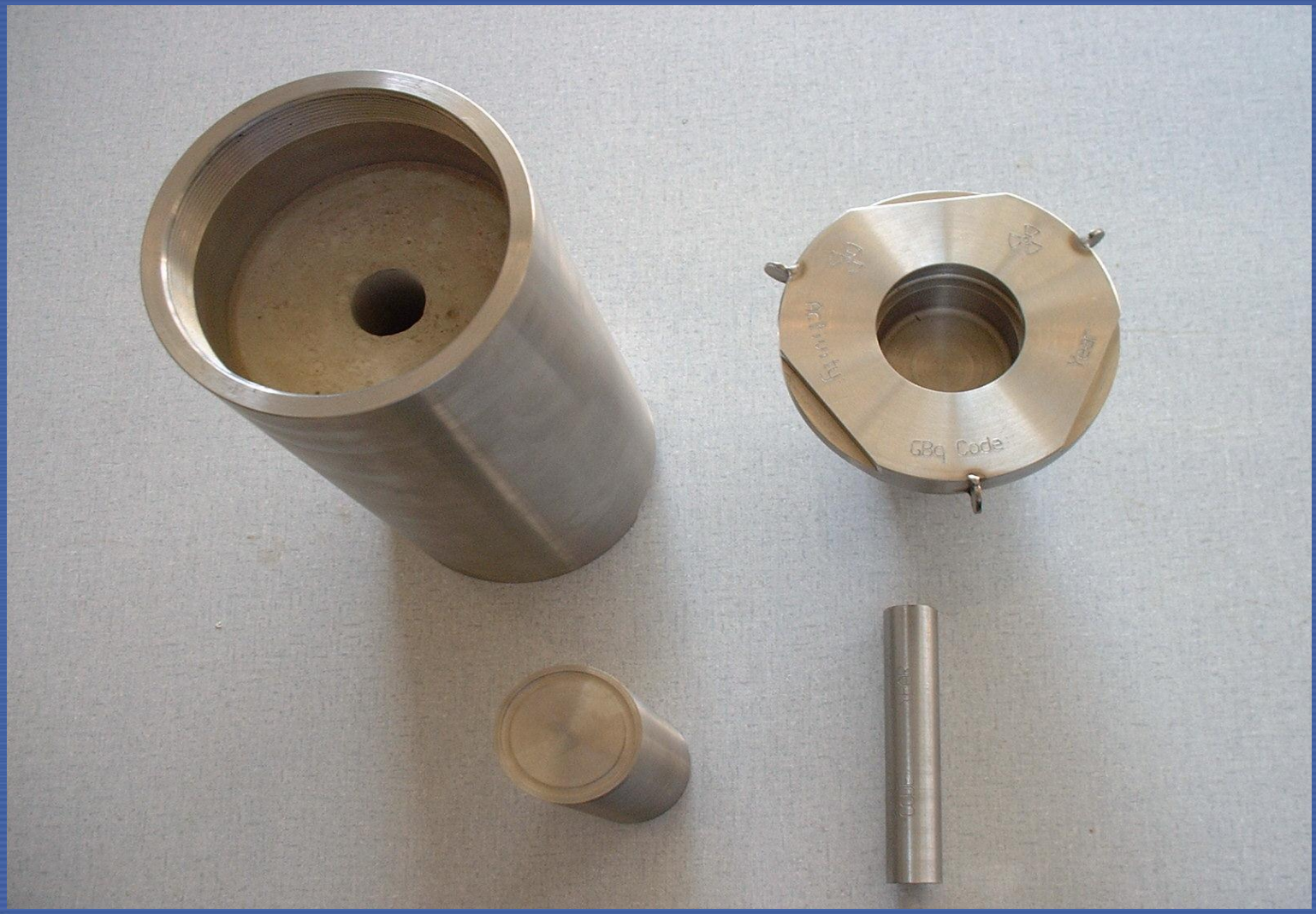
Disposal container (with partial cement fill) and container lid. Bottom row: sealed capsules in two sizes.



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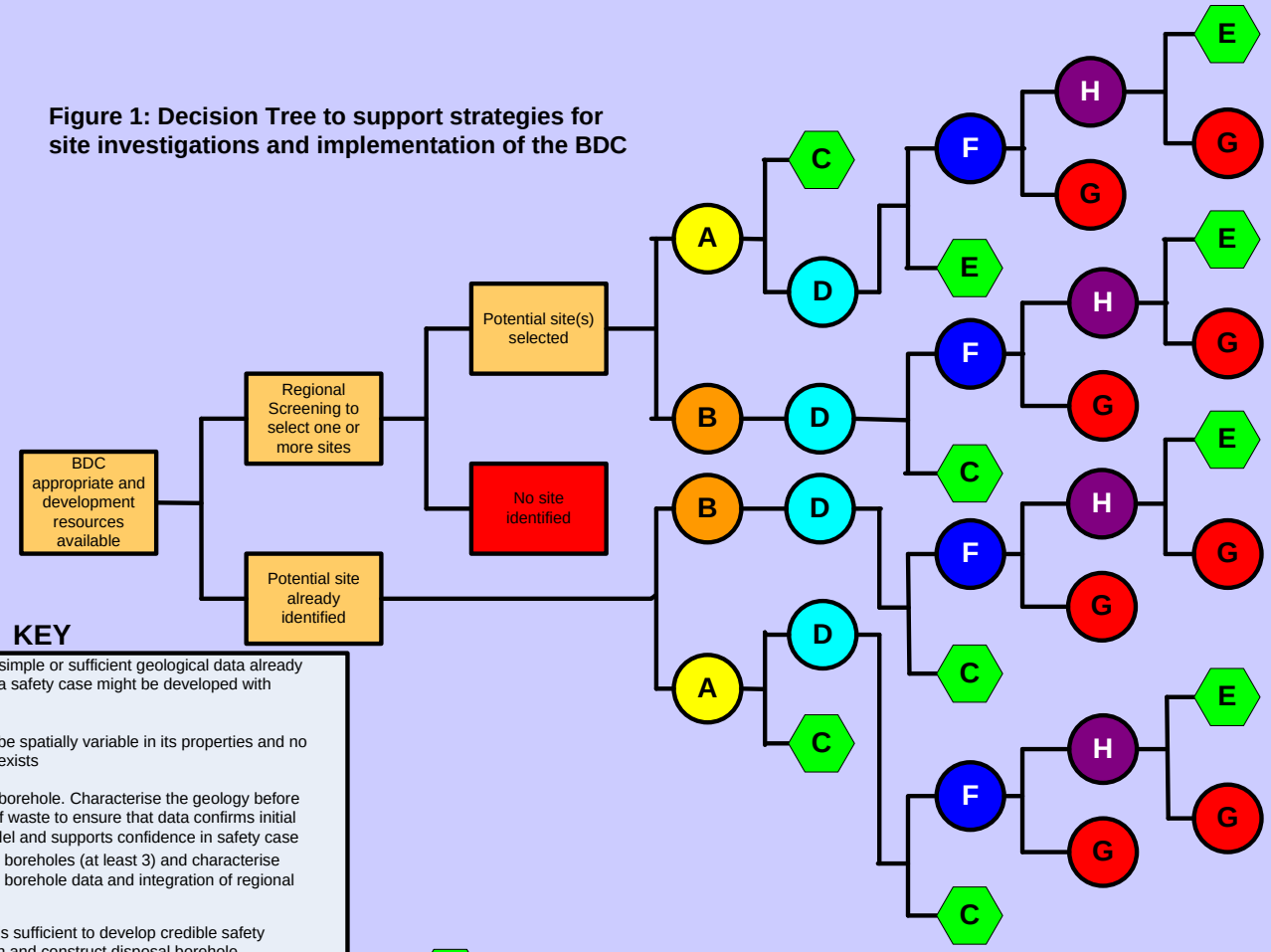
Mobile Hot Cell

Siting

Figure 1: Decision Tree to support strategies for site investigations and implementation of the BDC



KEY

- **A** — Site is relatively simple or sufficient geological data already exists such that a safety case might be developed with confidence
- **B** — Site appears to be spatially variable in its properties and no geological data exists
- **C** — Drill a disposal borehole. Characterise the geology before emplacement of waste to ensure that data confirms initial conceptual model and supports confidence in safety case
- **D** — Drill exploration boreholes (at least 3) and characterise the site through borehole data and integration of regional understanding
- **E** — Understanding is sufficient to develop credible safety case and design and construct disposal borehole
- **F** — Multiple interpretations are possible based on significant uncertainties so demonstration of robust safety case is not possible
- **G** — Abandon the boreholes and site due to complexity and/or potential future costs
- **H** — Drill new exploration boreholes and/or undertake further surface-based geological investigations

C and E are both considered successful outcomes

Site Investigations

- Regional studies and site data compilation
- Surface-Based Geophysics
- Drilling, casing and borehole completion
- Logging of cores and rock samples
- In situ hydro-testing and instrumentation
- Groundwater sampling
- Down-hole wireline geophysical logging
- Laboratory testing and analysis
- Integration, Interpretation and Reporting

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Construction of a borehole using percussion drilling

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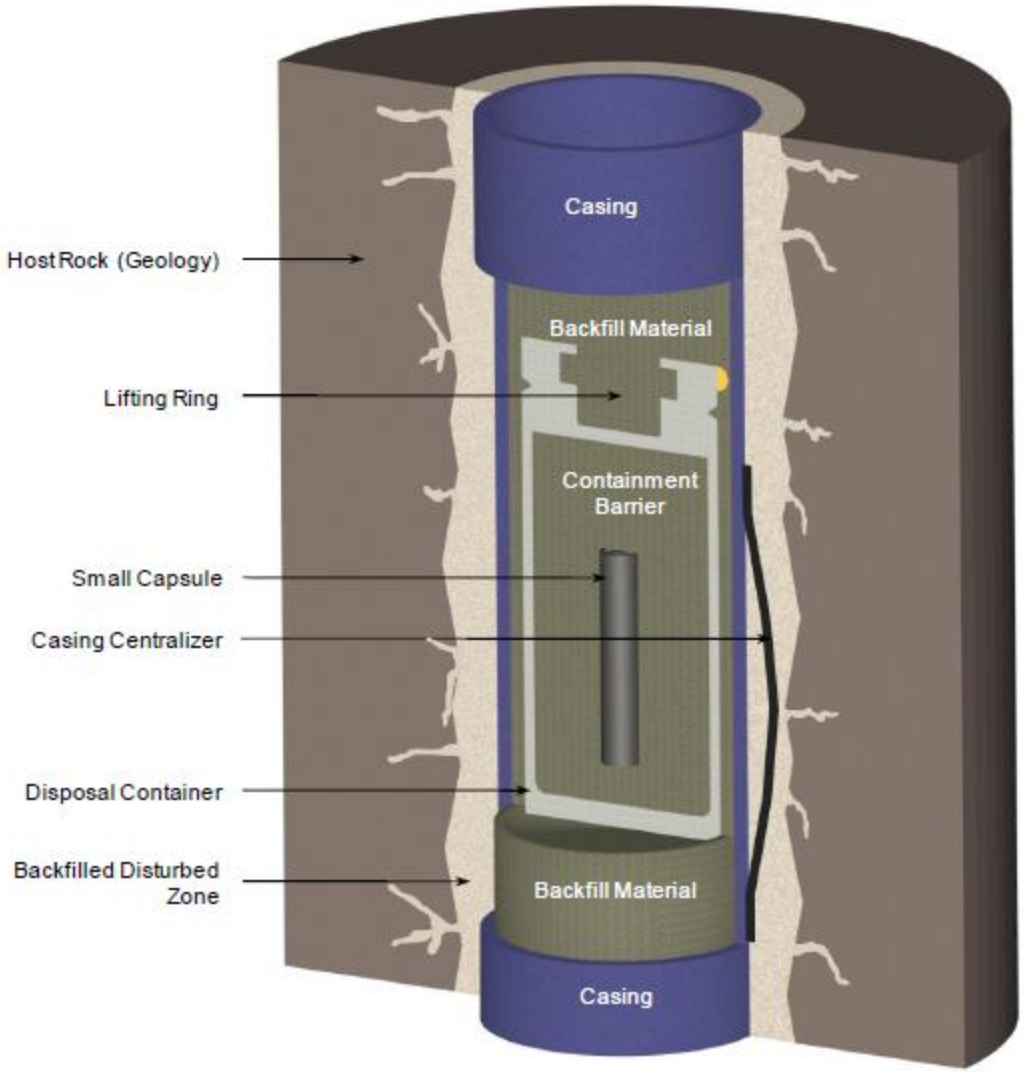
The Engineered System

Borehole
Diameter – 260mm
Length – variable

Casing
Diameter – 160mm
Length - variable

Disposal Container
Diameter – 115mm
Length – 250mm

Capsule
Diameter - 21/48mm
Length – 110/121mm



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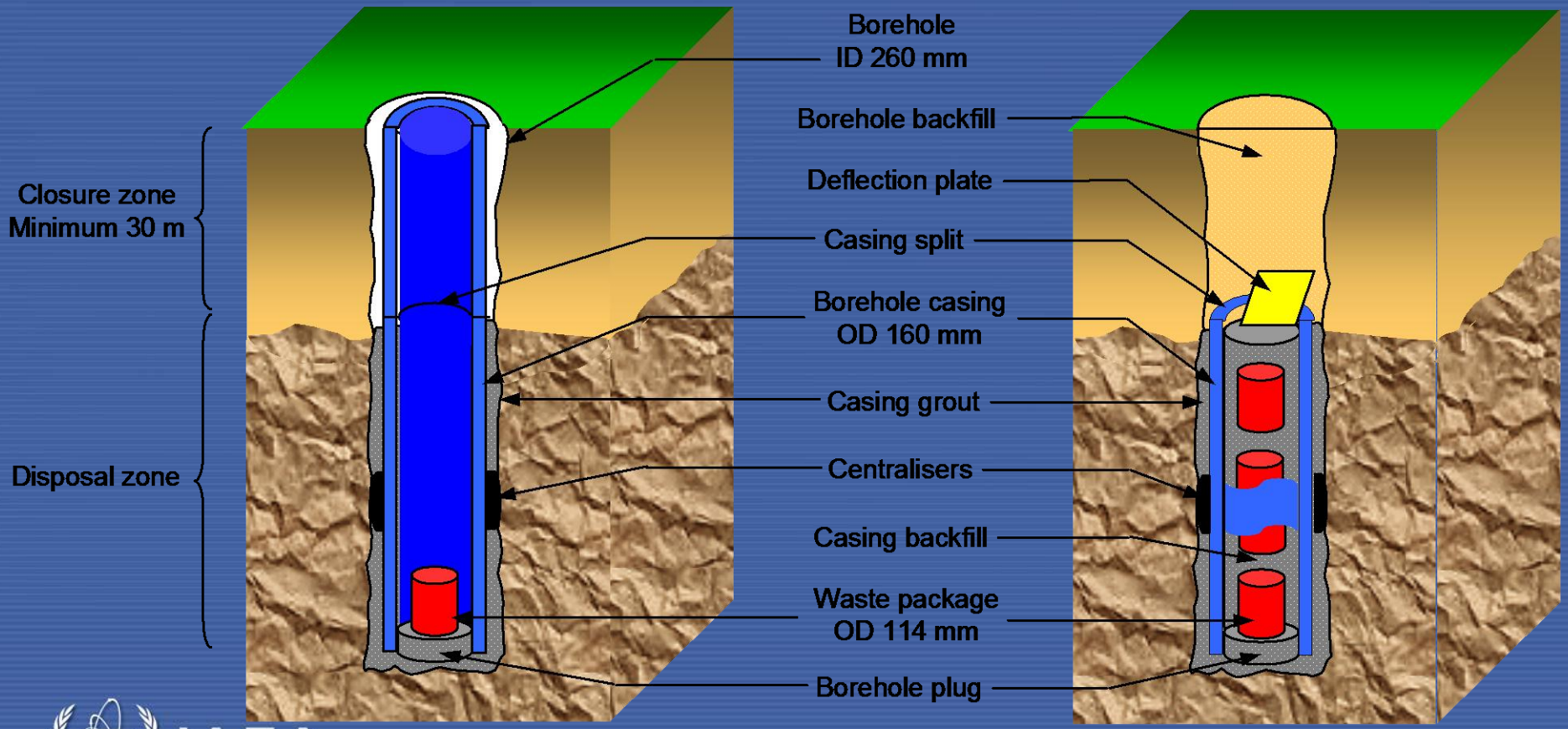
Schematic representation of the Emplacement Borehole



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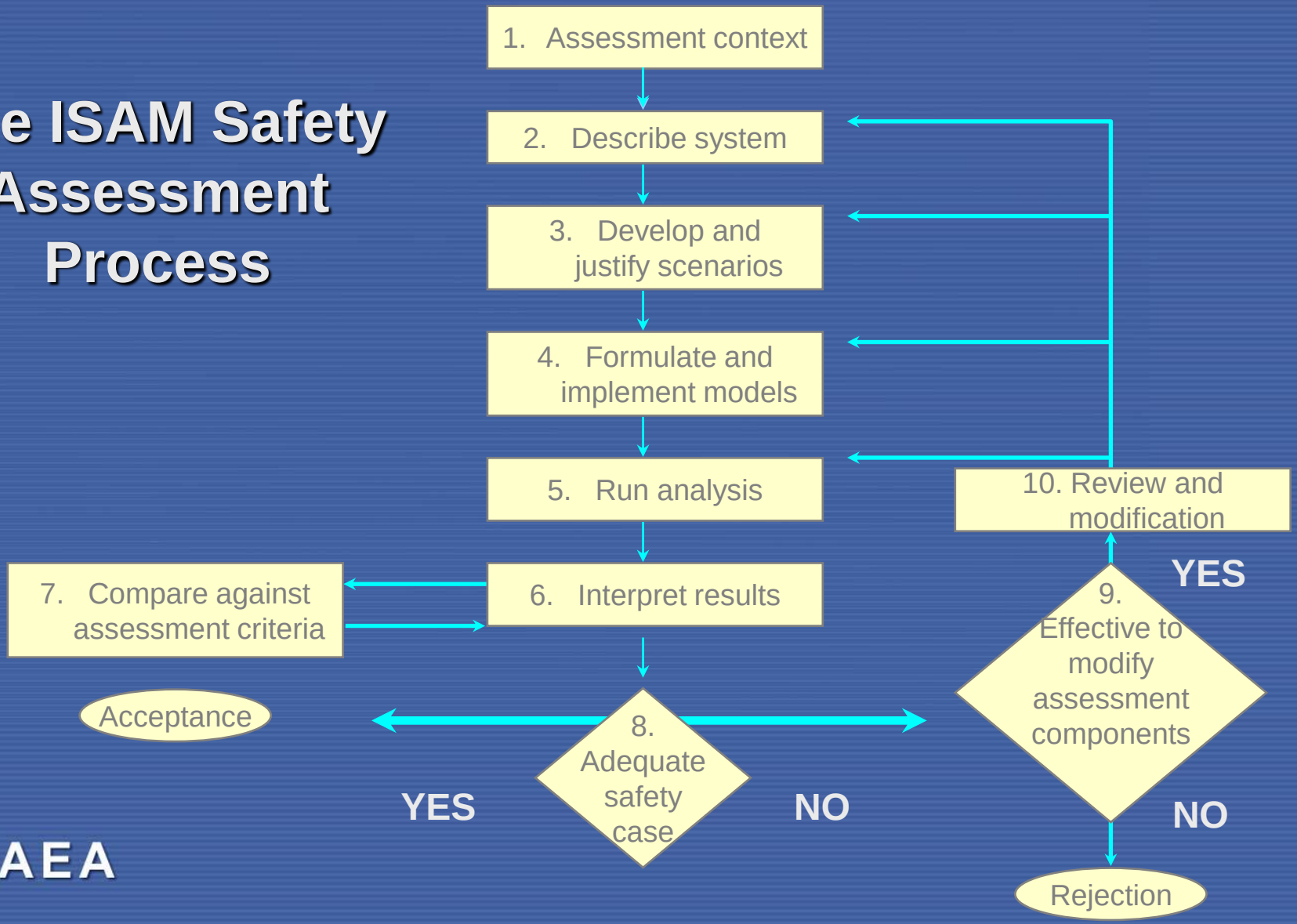
Safety Assessment

The ISAM Safety Assessment Process



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Safety Assessment & Safety Case Development

Natural releases

- Safety rests to large extent on physical containment in near field engineered system
  - choice of materials
  - importance of hydrogeochemistry
- Geosphere provides isolation and secondary barrier
  - saturated or unsaturated zone
  - retardation
  - dilution & dispersion

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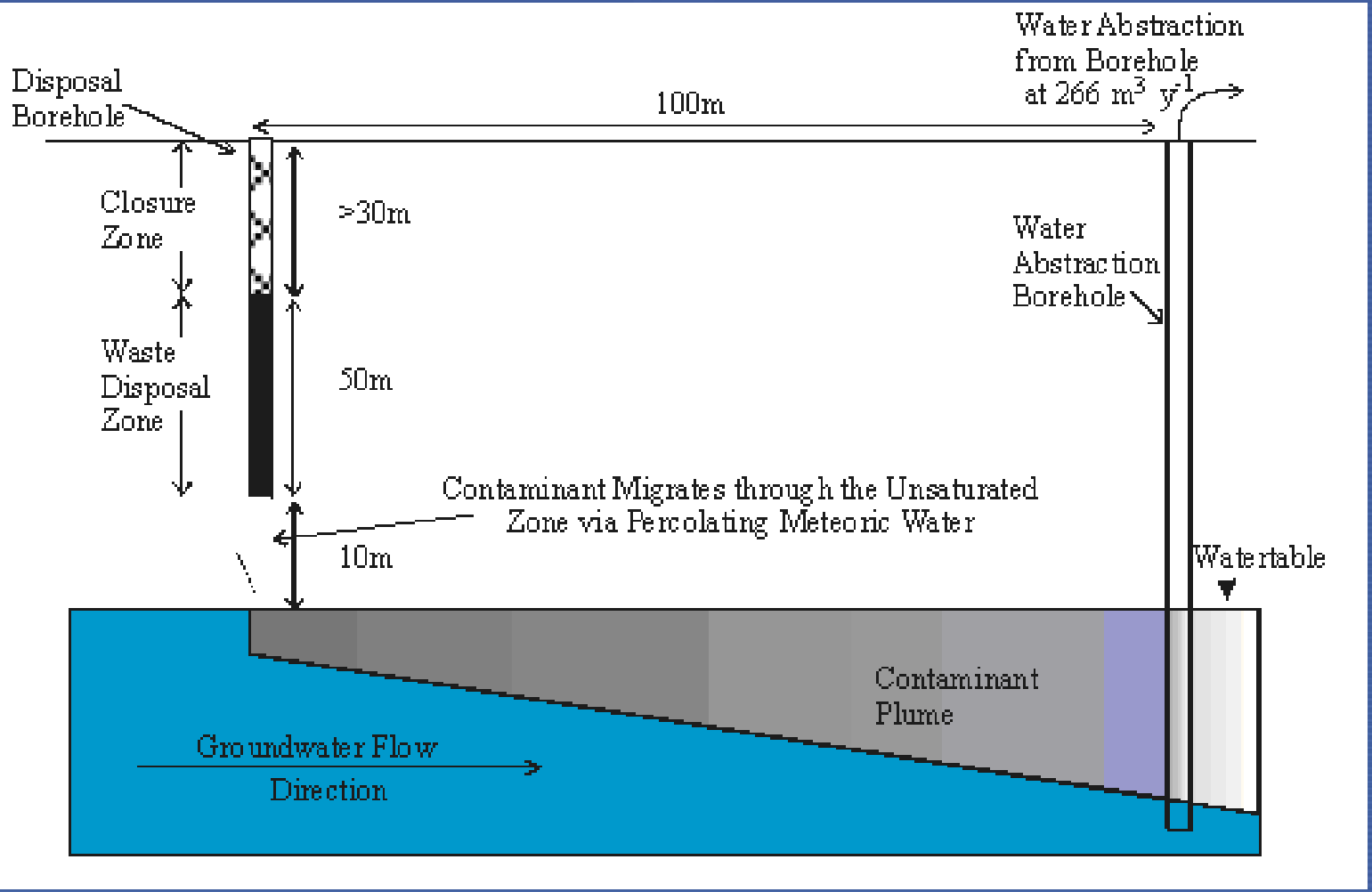
Potential Pathways



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Reducing Potential for Human Intrusion

- Depth >30 m below erosional surface
- Deflector plate
- Small footprint
- Removal of top casing
- Use of non-metallic casing
- Possible use of non-metallic canisters
- Native soil for top 2m
- Institutional control
- Markers may or may not be used

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Summary of Benefits from Borehole Disposal for DSRS

Advantages

- Variable borehole depth or use of multiple boreholes → provides capacity to deal with range of inventory sizes (or to accommodate site specific features)
- Small footprint and can include other features to enhance security → robust to deliberate or inadvertent Human Intrusion
- Small volume excavation → cost-effective and affordable
- Use of simple, readily available technology → easy logistics and sourcing of materials and skills
- Simplified safety assessment → meets all safety requirements for disposal

Additional Considerations

- Limited volume capacity per BH
- Difficult retrieval
- May be operational difficulties

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Current Barriers to Implementation

- National Policy & Strategy and allocation of Responsibilities
- Legal and Regulatory Framework
- Funding
- Technical Capacity and Capabilities

- Full Integration of BOSS for Category 1 & 2/3 sources (use of Mobile Hot Cell)

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First Steps – IAEA Fact Finding Mission (Pre-requisites)

- Assess the suitability of the legal and regulatory framework;
- Gain mutual assurance that responsibilities for regulation and implementation of BOSS can be allocated to appropriately competent bodies;
- Review the status of the national inventory of DSRS that has been compiled; and
- Clarify that there is a clear commitment from national authorities to support the siting, approval and implementation of BOSS through an appropriate national radioactive waste management policy or strategy.

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IAEA Assistance

- **Strategic Planning**
- **The provision of technical advice, equipment, services and equipment**
- **Training courses, fellowships, workshops, scientific visits**

NB Planning for next TCP cycle (2014/15) underway

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PLEASE NOTE:

- New (2012) IAEA project INT9176: '**Strengthening Cradle-to-Grave Control of Disused Sealed Radioactive Sources in the Mediterranean Region**'

- Collaboration between IAEA (TC, NE & NS Departments) and European Commission with scope for wider support and involvement.

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Specific Areas for IAEA Support

- Ensure Pre-requisites are met
- Review inventory and establish preliminary Waste Acceptance Criteria
- Organise planning and implementation of pre-disposal activities
- Support national siting and site investigations
- Provide appropriate repository design and support construction
- Safety demonstration (incl. safety assessment)
- Support waste emplacement and sealing activities
- Support for regulatory authorities

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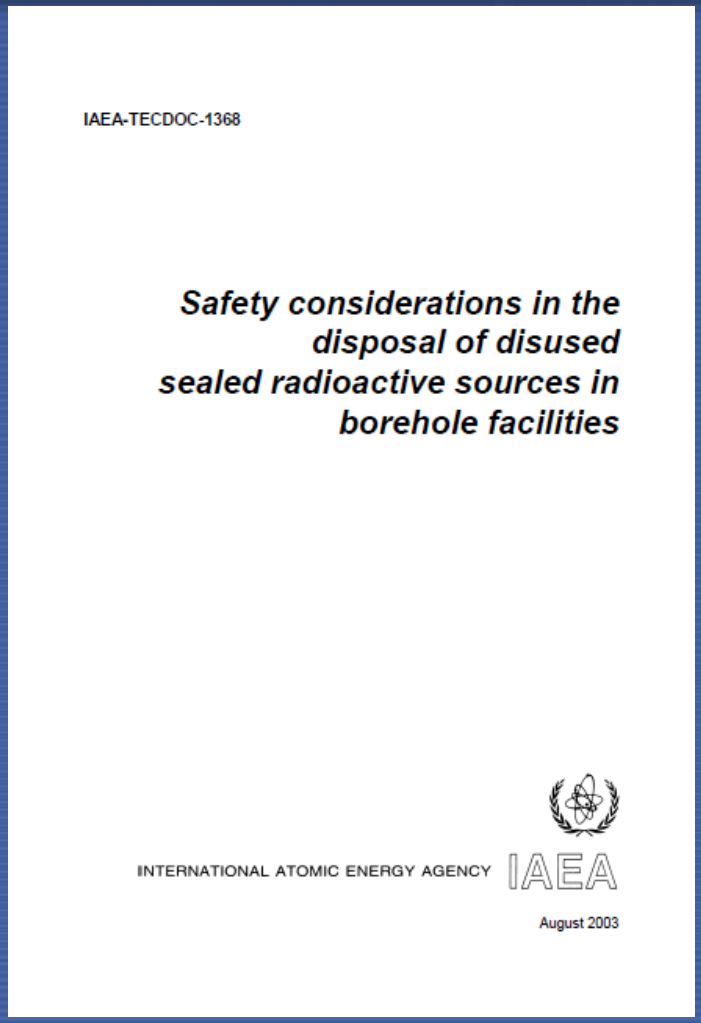
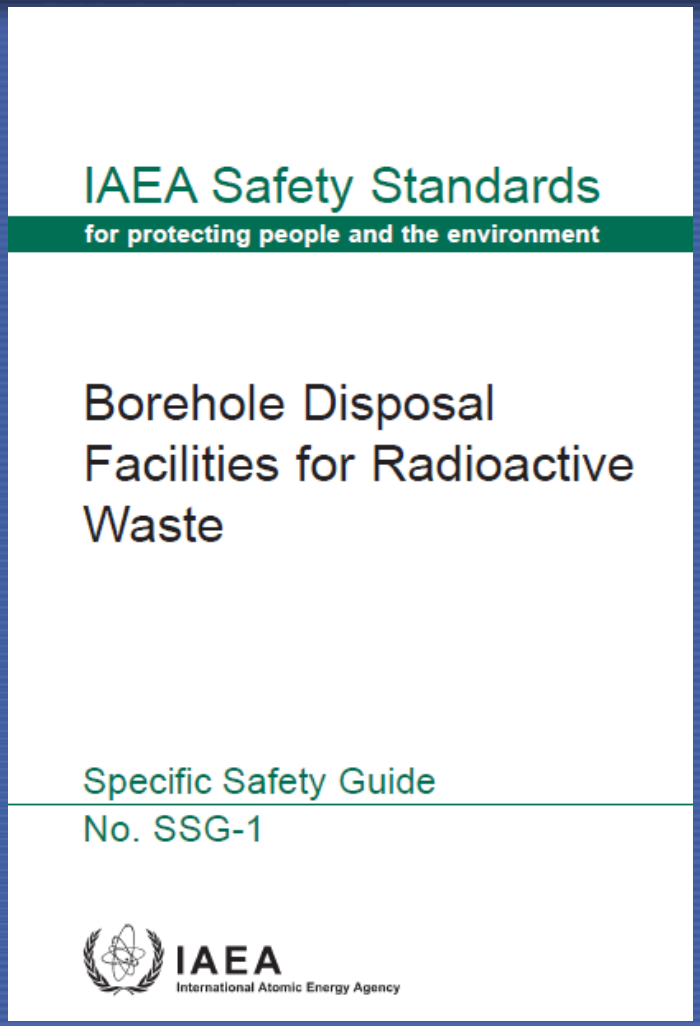
Published IAEA Documents


IAEA-TECDOC-1368

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

INTERNATIONAL ATOMIC ENERGY AGENCY IAEA

August 2003


IAEA Safety Standards

for protecting people and the environment

Borehole Disposal Facilities for Radioactive Waste

Specific Safety Guide

No. SSG-1

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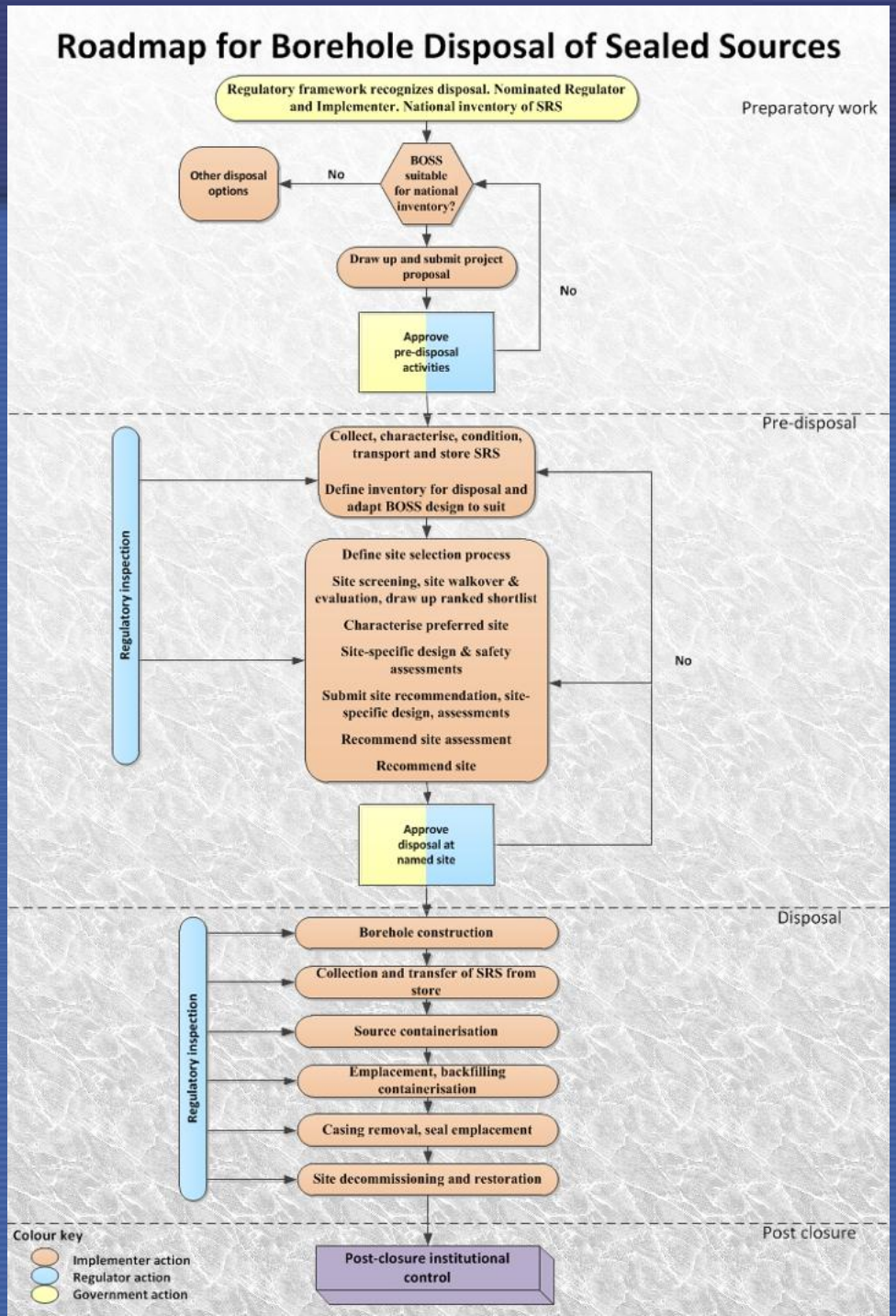
Many unpublished reports (including GSA)

See Brochure:



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Conclusions

- The BDC concept is ready for implementation and IAEA support is available.
- The choice of appropriate inventory, repository design and geological environment will ensure safety.
- As well as ensuring safety, the BOSS system is a cost-effective, secure, practical and a permanent means of disposing of a wide range of DSRS
- The BOSS concept will be suitable for dealing with Category 1 & 2 DSRS (subject to development of minor design elements)

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National Commitment and International Support is Critical

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Thank you for your attention