Radioactive Waste Management

The UK's approach to retrievability

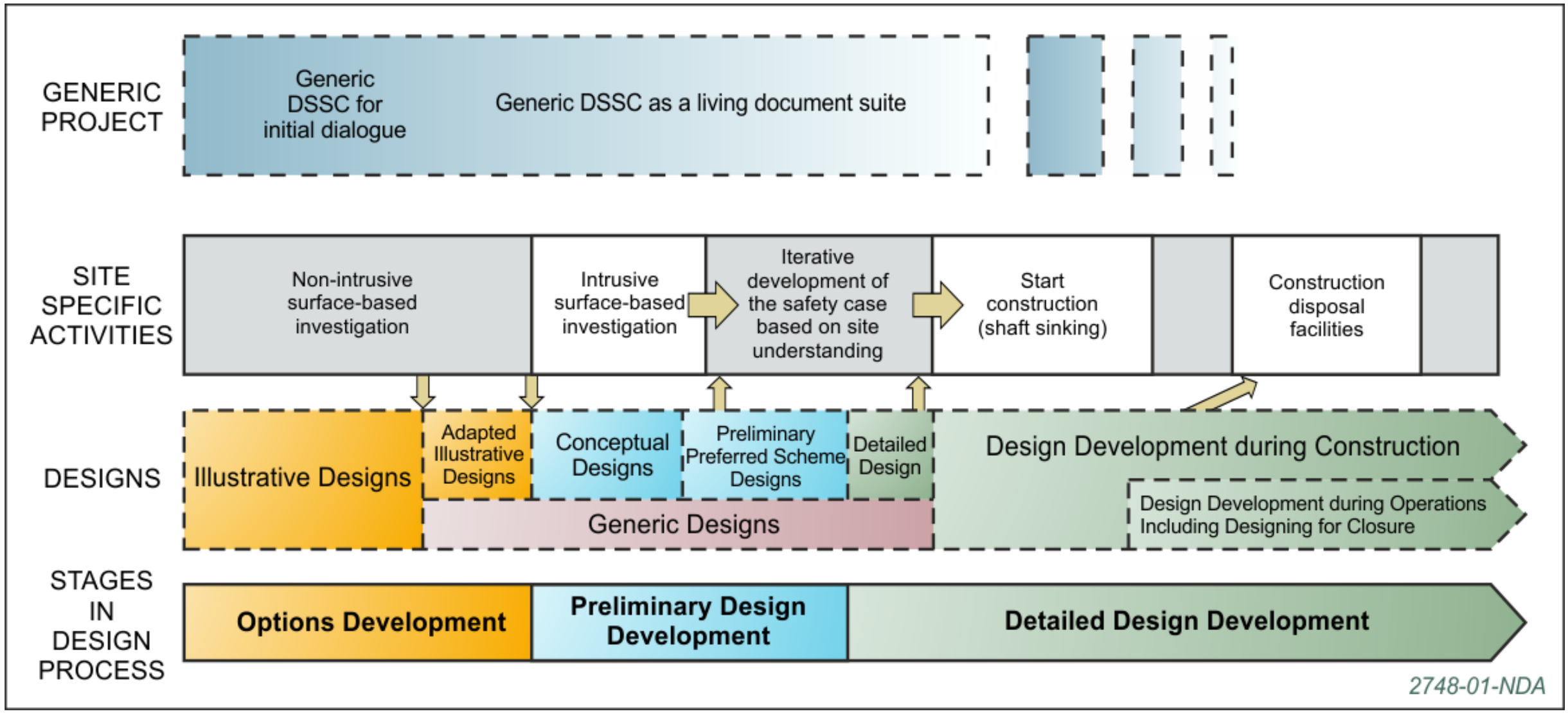
IGD-TP EF8 Technical Topic Session: Technical Issues in Support of Retrievability

Neil Carr, Principal Engineering Manager, RWM

4th December 2018

Radioactive Waste Management

GDF Design Development

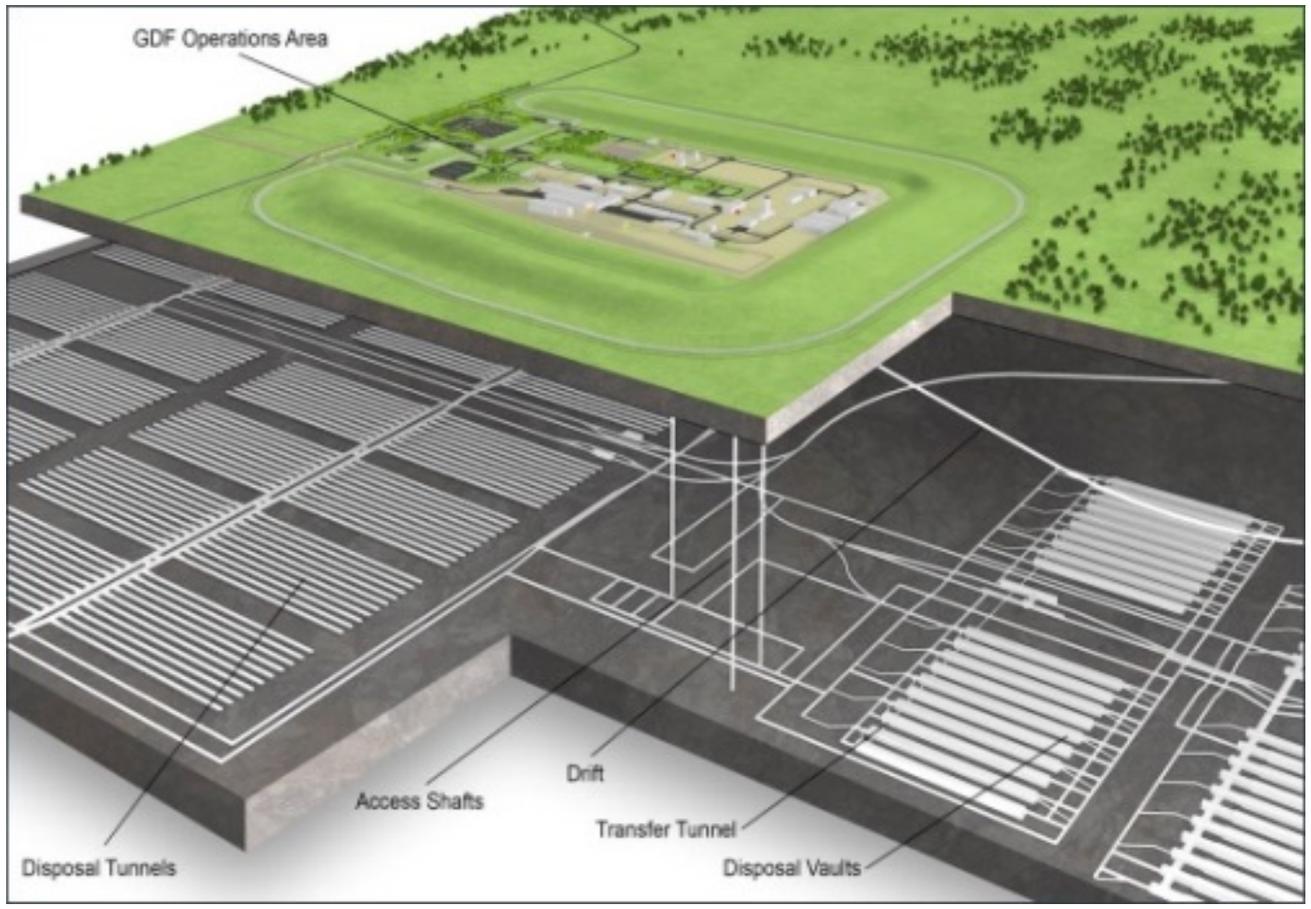


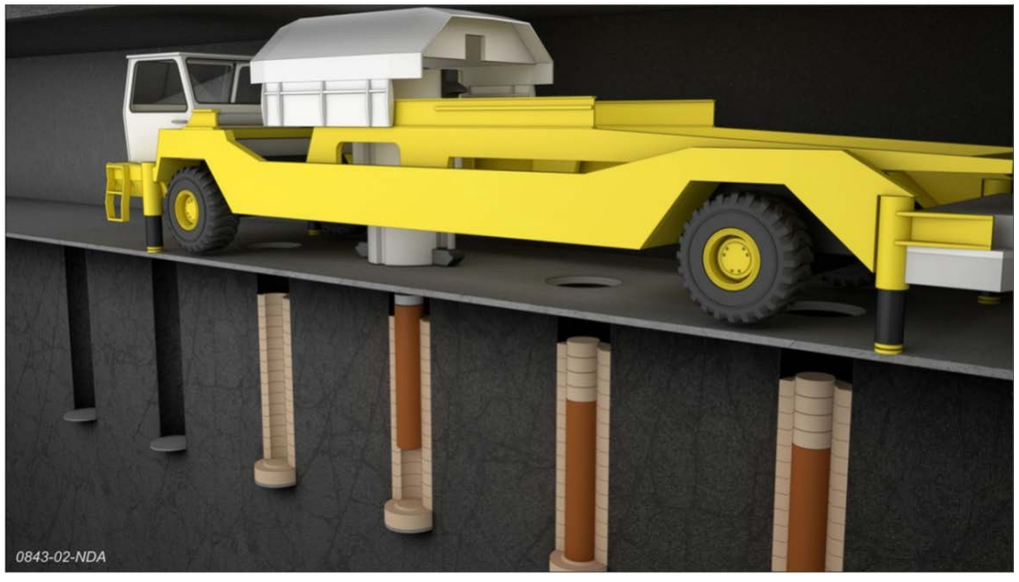
- Prepared for three generic host geological environments
- Illustrative designs support the assessment of safety, environmental, social and economic impacts of the Geological Disposal Facility

Radioactive Waste Management

UK Geological Disposal Facility

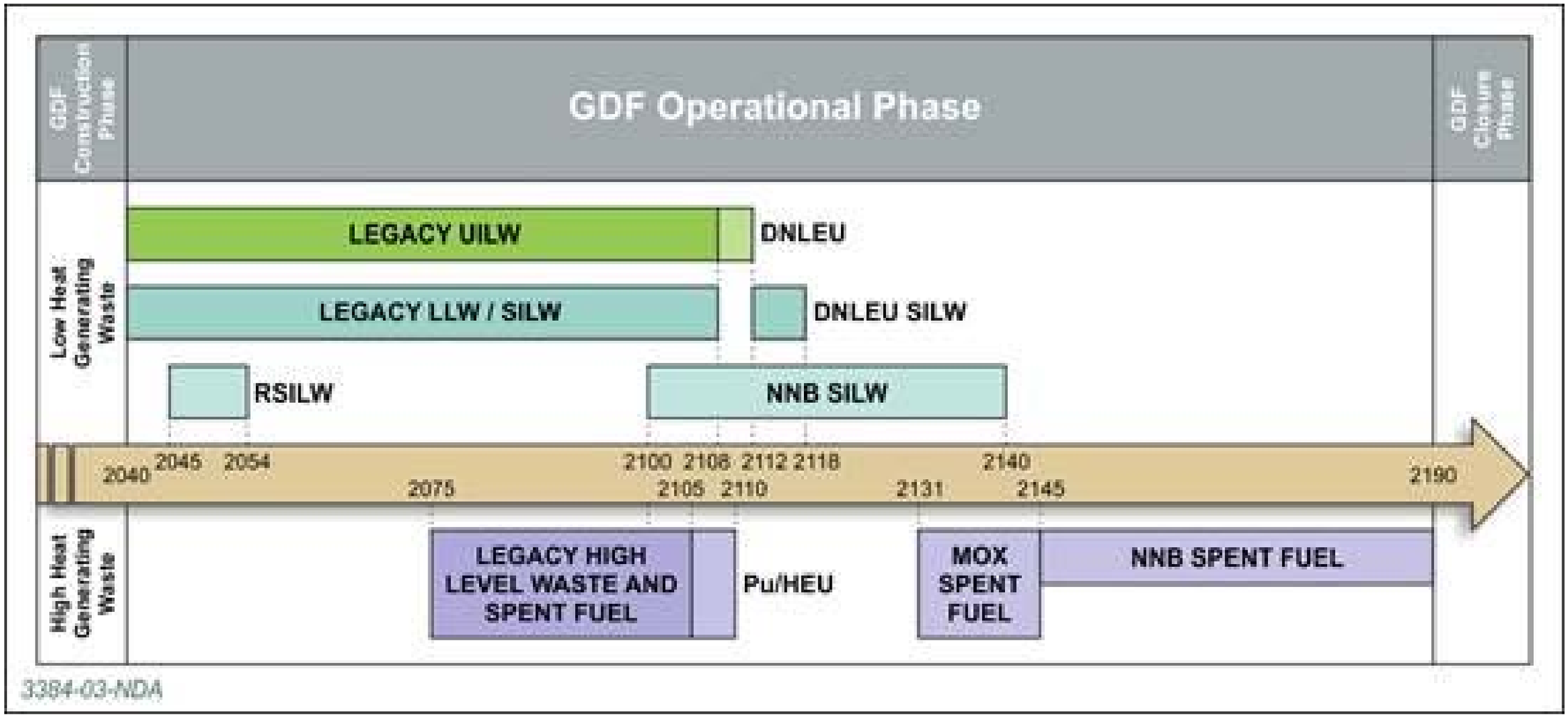
- The facility will dispose of LHGW and HHGW
- Illustrative designs have bee prepared for three host rock types





Radioactive Waste Management

Geological Disposal Facility Programme



Radioactive Waste Management

UK Definitions of Retrievability

The term ‘retrievability’ is used as an overarching term to refer to a number of different approaches to removal of radioactive waste from the GDF after it has been emplaced.

• **Reversibility –** retrieval by reversing the original emplacement process, (removal of emplaced waste packages using the vault emplacement crane)

• **Retrievability –** where it is possible to withdraw the waste from the GDF by building in a methodology that would allow access to the waste even after vaults and tunnels had been backfilled (keeping service tunnels open for a period after emplacement and vault/tunnel backfilling)

• **Recoverability –** define situations when removal of waste from a closed GDF by excavation or similar intrusive methods

Radioactive Waste Management

Current Approach to Retrievability

• The UK Government notes that decisions about whether or not to keep a facility open once operations cease can be made at a later date

• This will be undertaken by RWM in an integrated manner in discussion with the regulators and local host communities

• Planning, design and construction of a facility can be carried out in such a way that the option of **retrievability is not excluded but we will not explicitly design for it.**

Radioactive Waste Management

Current GDF illustrative designs

• GDF illustrative designs include consideration for retrievability of the waste

• This could be due to a situation arising in the future where this waste requires to be removed from the facility due (for example, to local policy decisions or an advance in technology which allows for the re-use of the materials)

• A small number of design features are included in the existing GDF illustrative designs and these features include:

Radioactive Waste Management

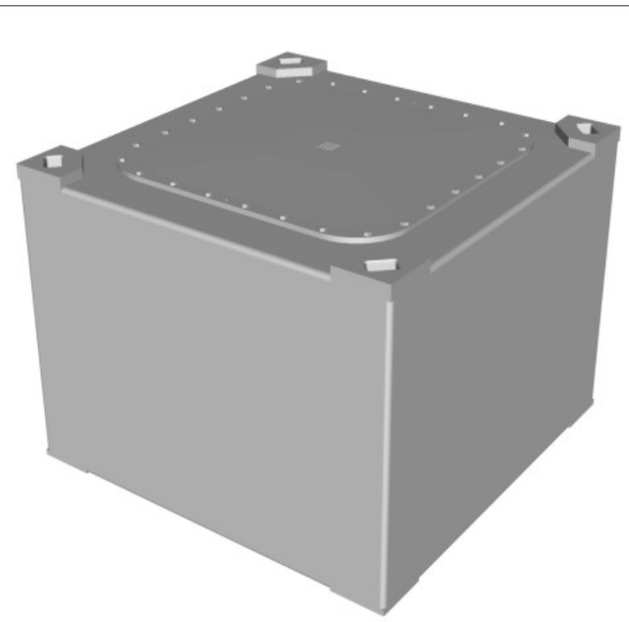
Waste Packages

• The waste packages for LHGW are designed to provide containment and enable safe handling for < 500 years.

• This anticipated package integrity would reduce the risks related to retrievability in the longer term

2644-01-NDA

3 cubic metre Box - Side lifting variant



3 cubic metre Box - Corner lifting variant

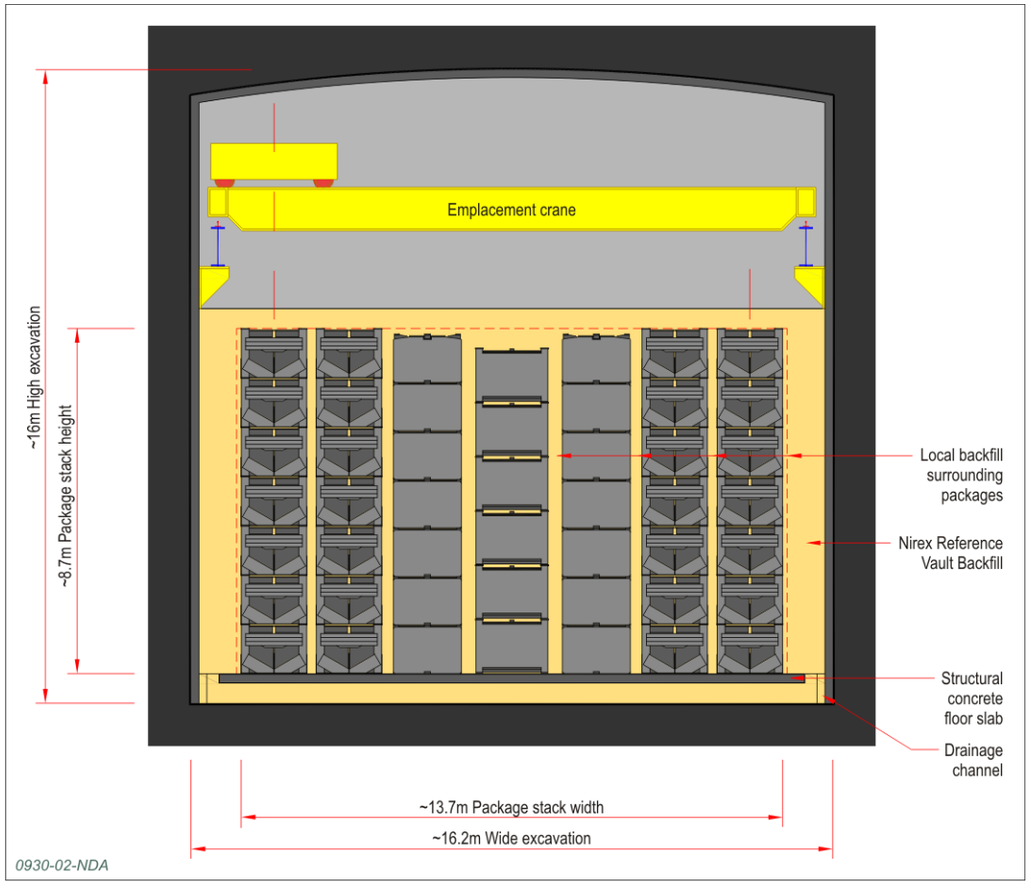
1157-01-NDA

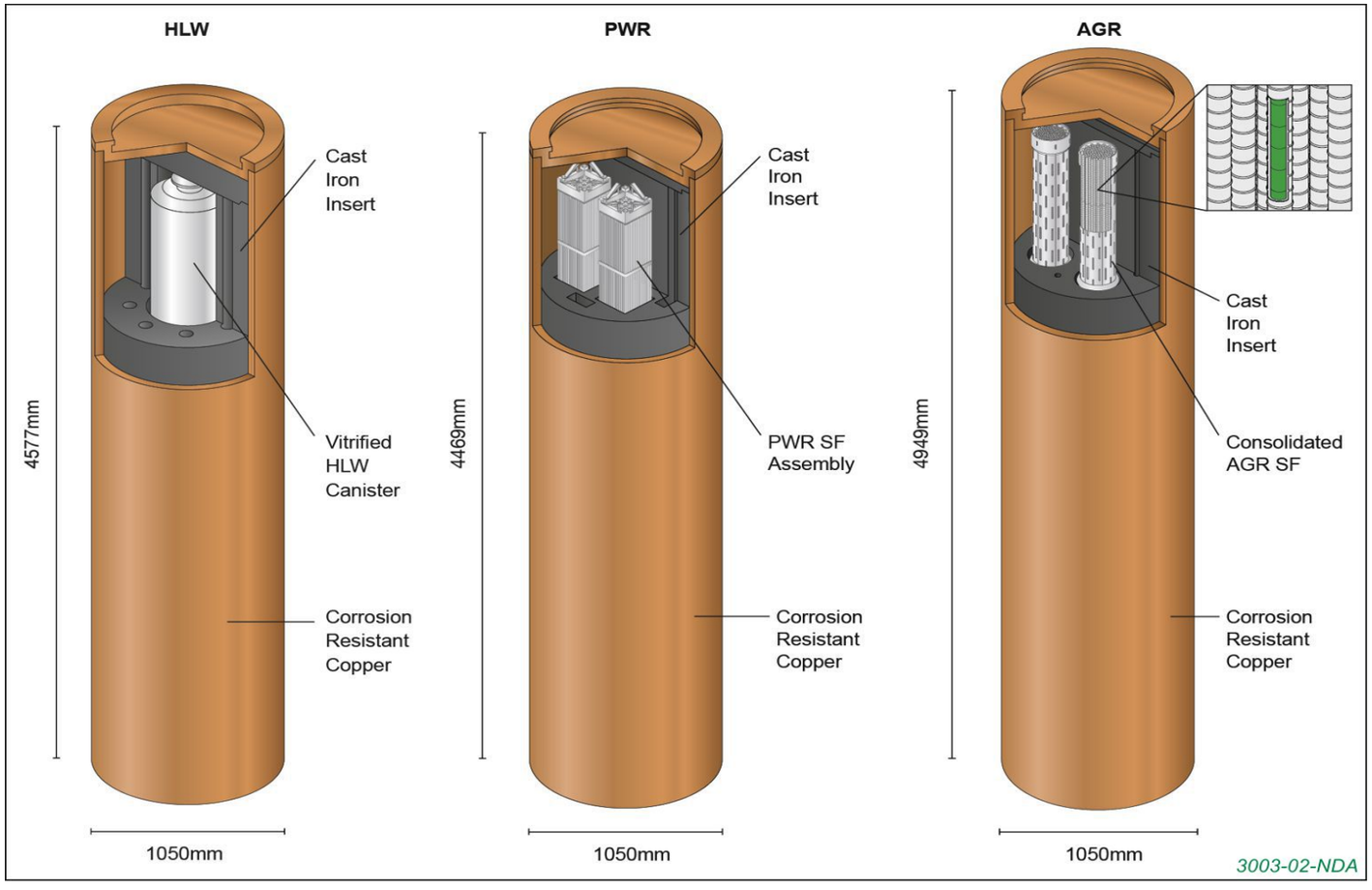
Radioactive Waste Management

GDF features

• The HHGW disposal containers have been developed with a handling feature at either end to enable disposal containers to be removed from the deposition holes / disposal tunnels, if required.

• Nirex Reference Vault Backfill (NRVB) is to be used as backfill in the higher strength rock illustrative design. This is an engineered grout that has alkaline properties to maintain package integrity and is of low strength to facilitate excavation of waste packages, if required.





LHGW Disposal Packages in HSR

- Stable vaults will allow disposal vaults to remain open until all the waste has been emplaced, when a decision to backfill all vaults could be taken
- Assuming appropriate control of environmental conditions to ensure package integrity, reversal of the emplacement process would only require re-use of the emplacement system
- Once vaults are backfilled the waste packages would be more difficult to retrieve, and a programme of backfill removal would be required. Studies have been undertaken to demonstrate retrievability of LHGW packages using high-pressure water jets to retrieve backfilled with NRVB
- However leaving filled vaults open introduces risks associated with unexpected mechanical failure of the rock, build-up of explosive gasses and accelerated degradation of the waste packages as well as significantly increasing the overall ventilation quantity requirements
- There is a driver to backfill each disposal vault immediately following emplacement reduces these risks and provides physical protection for the waste packages

Radioactive Waste Management

Consideration of other rock types

Lower Strength Sedimentary Rock and Evaporite Rock

- The disposal vaults will be backfilled after each vault is full
- Once vaults are backfilled the waste packages would be more difficult to retrieve, and a programme of backfill removal would be required
- Depending on the creep rate of the host rock, packages will be more difficult to retrieve through time. After extended periods, a programme of re-excavation would be the only way to recover the waste packages

Radioactive Waste Management

HHGW Disposal Containers in HSR

- Assumes that a buffer is emplaced in each disposal hole at the same time as emplacement of the disposal container
- Disposal tunnels would be backfilled as soon as all the disposal holes within it are filled. Therefore, the potential for reversal of the emplacement process is limited to a short period
- SKB has demonstrated that a saturated bentonite buffer can be removed from a disposal hole by slurrying it with a saline solution
- Should a decision be taken to retrieve disposal containers once backfilling of the disposal tunnel has taken place, retrieval would require dismantling of the disposal tunnel plug and excavation of the bentonite backfill
- SKB have tested the dismantling of disposal tunnel plugs, deposition tunnel backfill and disposal hole buffer as part of the Prototype Repository Project
- Recovery of the disposed spent fuel following closure would also require re-mining of the mass backfill emplaced in the access tunnels

Consideration of other rock types

Lower Strength Sedimentary Rock

- Assumes that each disposal tunnel would be backfilled progressively with a dry granulated bentonite buffer as the disposal containers are emplaced
- This system is not readily reversed, but it is technically feasible to remove the disposal container from the tunnel prior to sealing of the main access tunnels
- Should the requirement arise to recover the disposal containers, once backfilling of the main access ways had taken place, then this would become a re-excavation process

Evaporite Rock

- Assumes that each disposal tunnel is backfilled progressively as the disposal containers are emplaced
- Once backfilling has taken place, then, should the requirement arise to recover the disposal containers, this would become a re-excavation process

GDF Designs for the NEA Retrievability Scale

• RWM staff participated in development of the Nuclear Energy Agency (NEA) retrievability scale

• Recent work by RWM in 2018 has reviewed the GDF designs against the different stages of the NEA scale to identify approaches for the retrieval of waste

NEA Retrievability Scale	Description of Stage	CoRWM Terminology	GDF Phase
Stage 1	Waste Package(s) in storage	Reversibility	Pre-construction/ Construction Phase
Stage 2	Waste Package(s) in disposal cell		Operational Phase
Stage 3	Waste Package(s) in sealed disposal cell	Retrievability	
Stage 4	Waste Package(s) in sealed disposal zone		Closure Phase
Stage 5	Waste Package(s) in a closed repository	Recoverability	Post-Closure Phase
Stage 6	Distant future evolution		

Radioactive Waste Management

GDF Designs for the NEA Retrievability Scale

- Study concludes that retrieval of wastes should be achievable and it is possible that existing technology could be used for retrieval
- However, the processes for retrieval of wastes become more difficult further down the NEA scale (the longer time passes following backfilling)
- It is likely that more novel technology and specifically designed machines may be required at these later stages
- It is possible that certain design changes may make retrieval of wastes easier if it was required in the future. This could include:
  - installation of fibreglass bolts in evaporite vaults and tunnels instead of steel to make it easier to cut through the bolts
  - use of NRVB in LHGW vaults in lower strength sedimentary rock instead of the currently proposed, stronger, cementitious grout. This would enable easier removal of grout during retrieval

GDF Designs for the NEA Retrievability Scale

Phase 2 (Work in progress)

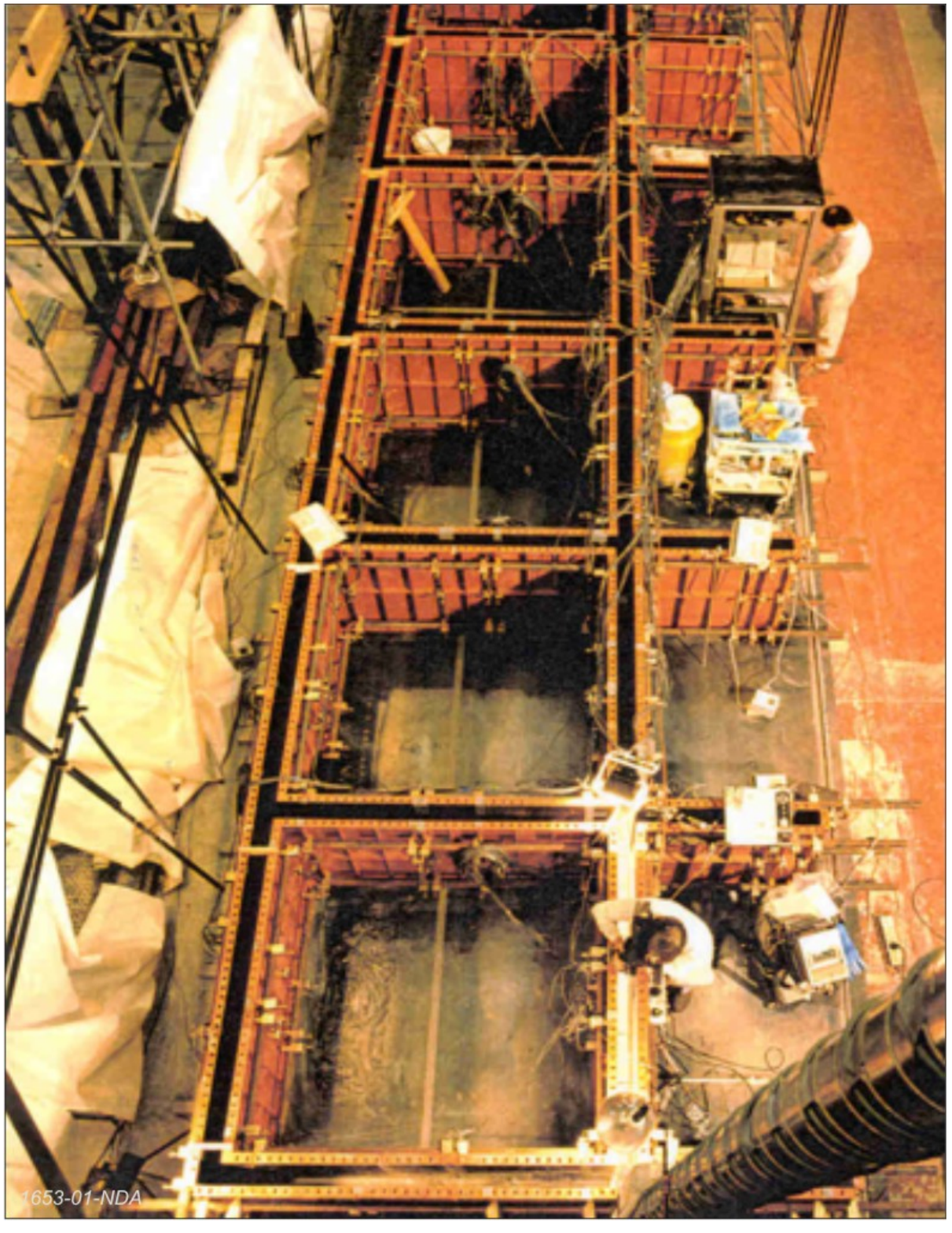
- Work ongoing is defining basic operability issues and identify hazards associated with the proposed retrieval methods for the different NEA stages
- This would identify the potential hazards associated with the waste retrieval process options identified in order to inform future decisions about proposed approaches to waste retrieval

Phase 3 will provide recommendations on the preferred options for retrieval of wastes, produce a Process Flow Diagram (PFD) for waste retrieval operations and recommend any design enhancements to the illustrative designs.

Radioactive Waste Management

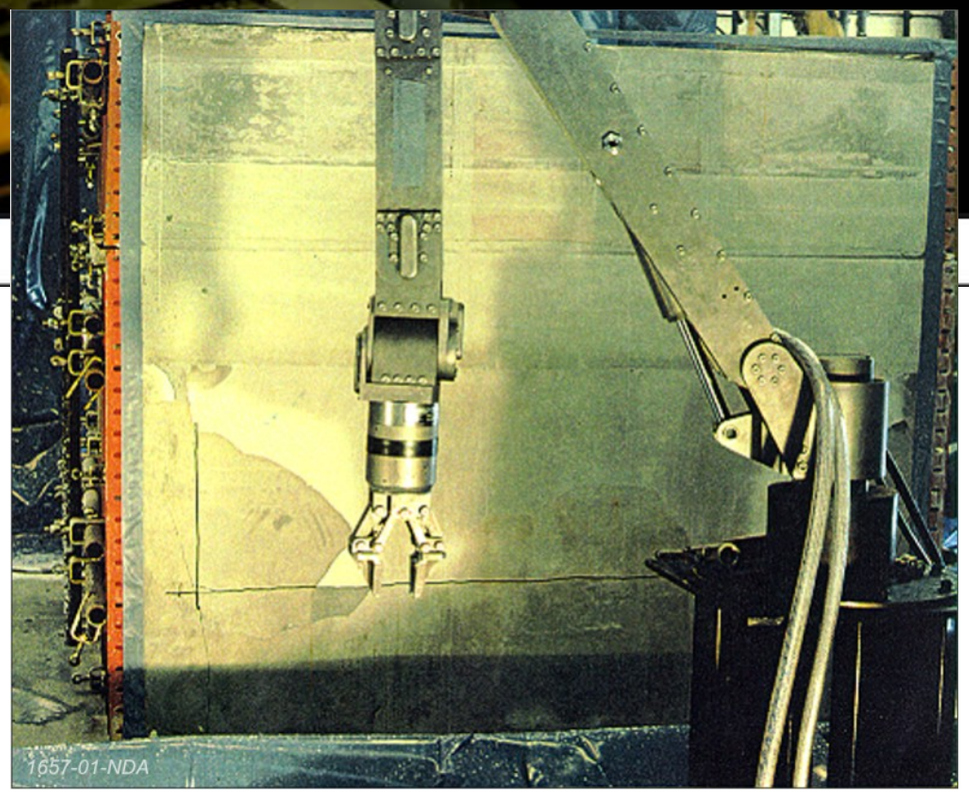
NRVB

Full scale Retrievability trials



Radioactive Waste Management

0257-02-NDA



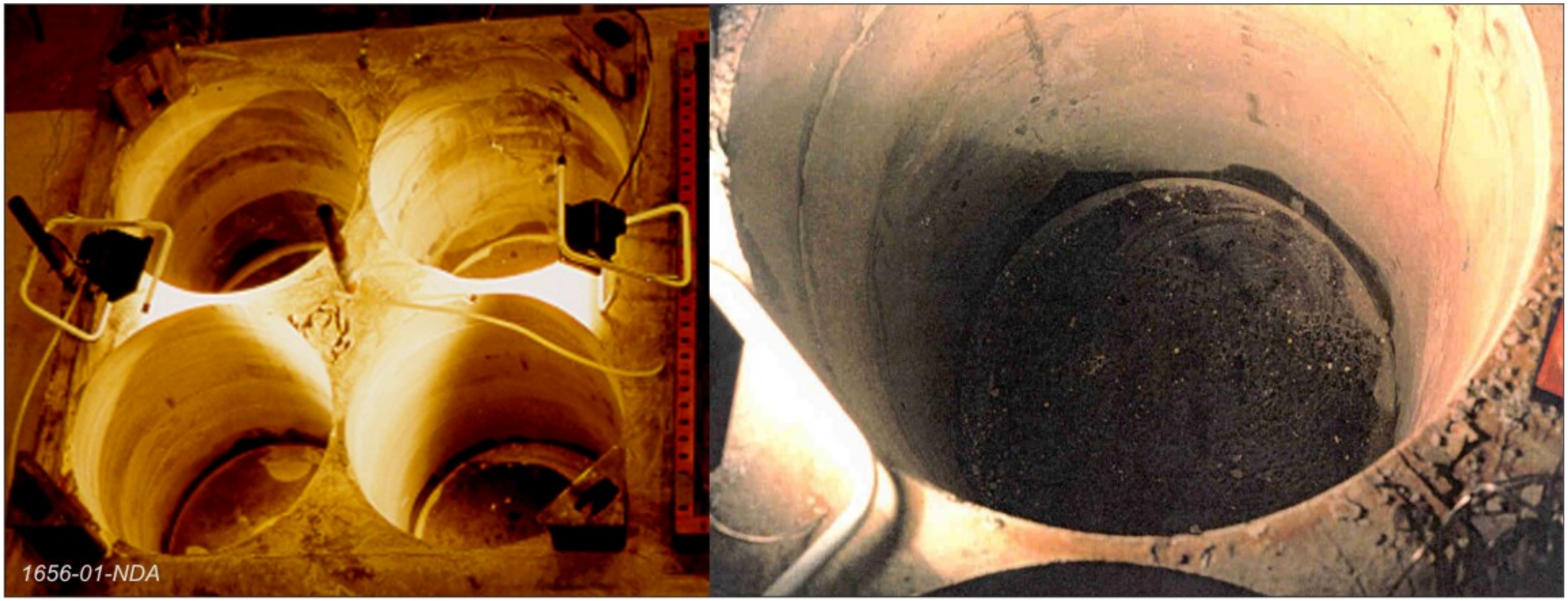
1657-01-NDA

Manual proof of concept and automated remote techniques deployed

Radioactive Waste Management

Waste package removal

Radioactive Waste Management



Results of water cutting of NRVB

Radioactive Waste Management

Thankyou for your attention

Questions

For further reading see RWM website:

https://rwm.nda.gov.uk/publications

Radioactive Waste Management