Overview of Adaptive Phased Management Repository Design Development

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nwmo

NUCLEAR WASTE MANAGEMENT ORGANIZATION

SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES

Overview of Design Development Program

- Nuclear Waste Management Organization
- Adaptive Phased Management
- Reference Repository Designs
- Design Development

Nuclear Waste Management Organization

- Nuclear Waste Management Organization (NWMO) provides long-term management of Canada's nuclear fuel waste
- NWMO was created and funded by the large nuclear utilities in 2002; operates as a non-for-profit organization
- Mission:

  To develop and implement collaboratively with Canadians, a management approach for the long-term care of Canada's used nuclear fuel that is socially acceptable, technically sound, environmentally responsible and economically feasible

- In 2007, Government of Canada accepted NWMO's recommendation of Adaptive Phased Management (APM) for long-term management of used nuclear fuel
- NWMO is implementing APM

Adaptive Phased Management

APM emerged from dialogue with citizens and experts – best met key priorities

A Technical Method

- Centralized containment and isolation of used nuclear fuel in deep geological repository
- Continuous monitoring
- Potential for retrievability
- Optional step of shallow underground storage

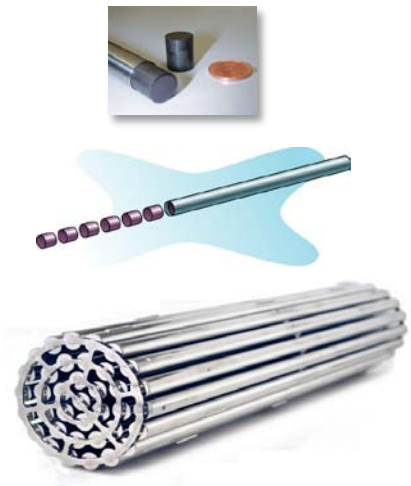
A Management System

- Flexibility in pace and manner of implementation
- Phased and adaptive decision-making
- Responsive to advances in technology, research, Aboriginal Traditional Knowledge, societal values
- Open, inclusive, fair siting process - seek informed, willing host community
- Sustained engagement of people and communities throughout implementation

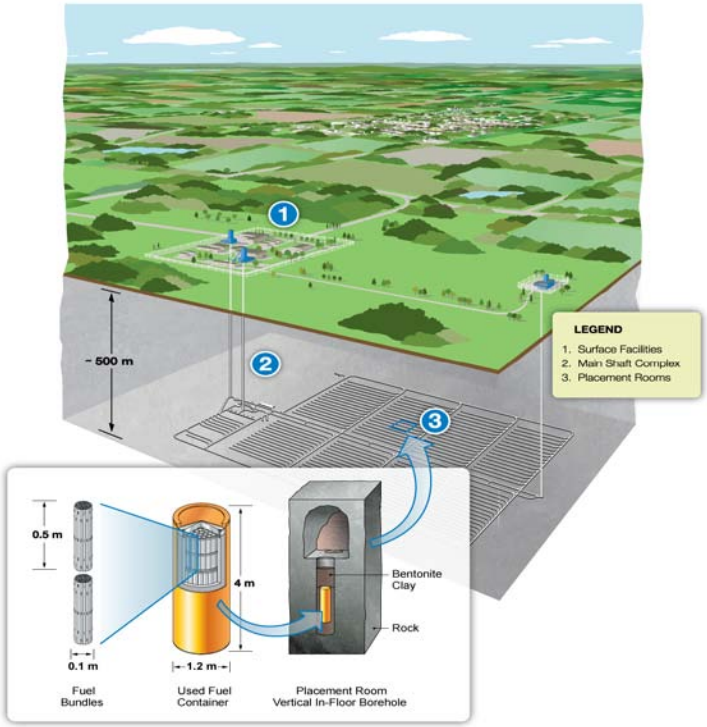
APM approved by Federal government June 2007

Adaptive Phased Management

- Adaptive Phased Management (APM) includes the siting, design and development of a deep geological repository & a transportation system for Canada's used nuclear fuel
- APM Technical Program assumes completion of generic technology development by 2018, assumed date for selection of preferred site



CANDU fuel bundle



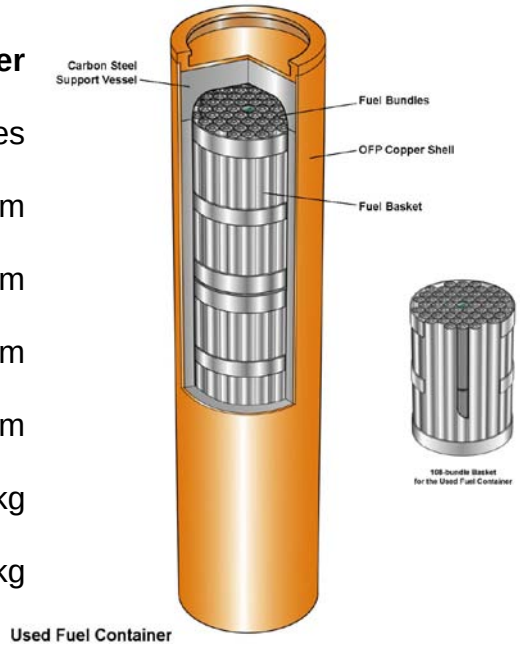
APM Deep Geological Repository

APM Transportation System

Conceptual Design – Used Fuel Container

- NWMO developing reference conceptual designs for a deep geological repository (DGR) in potentially suitable host rock formations:
  1. Crystalline Rock
  2. Sedimentary Rock
- Several container designs are being studied; here are 2 examples:

Outer Shell:	**Copper**
Capacity:	360 bundles
Length:	3.84 m
Diameter:	1.25 m
Cu Thickness:	25 mm
Fe Thickness:	102 mm
Mass (fuel):	8,640 kg
Total Mass:	27,000 kg



Copper Container

Steel Container

Outer Shell:	**Carbon Steel**
Capacity:	360 bundles
Length:	3.88 m
Diameter:	1.20 m
Thickness:	102 mm
Mass (fuel):	8,640 kg
Total Mass:	23,000 kg

APM Design – Used Fuel Packaging Plant

- Used Fuel Packaging Plant (UFPP) design:
  - Located adjacent to repository at APM facility site
  - Receives used fuel bundles transported from reactor storage sites
  - Process 120,000 used fuel bundles / year into 333 used fuel containers / year
  - Handling via Shielded Frame & Air-Cushion Transporter
  - Processing stations:
    - Fuel handling
    - Inerting
    - Welding (FSW or EB)
    - Machining
    - Inspection

Shielded Frame & Air-Cushion Transporter

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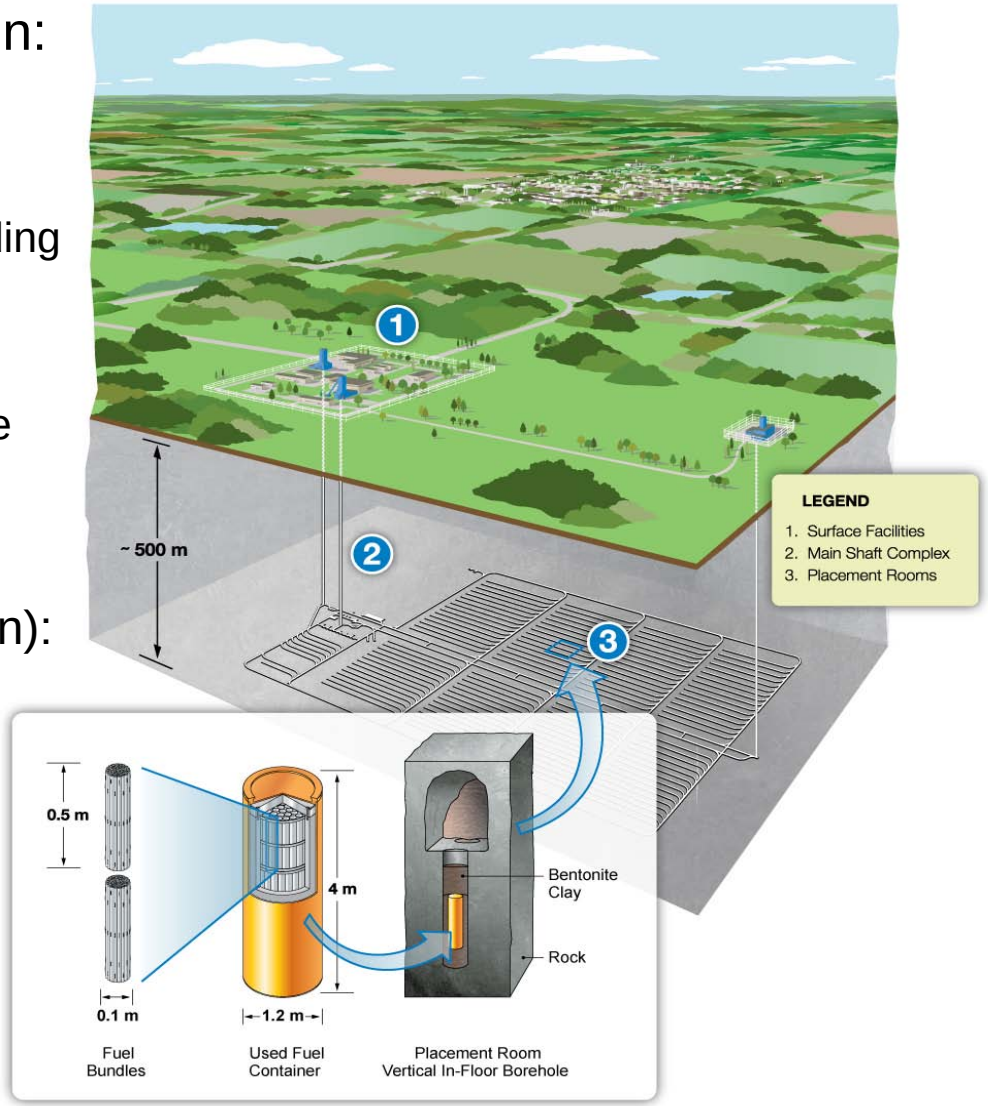
Inerting Station

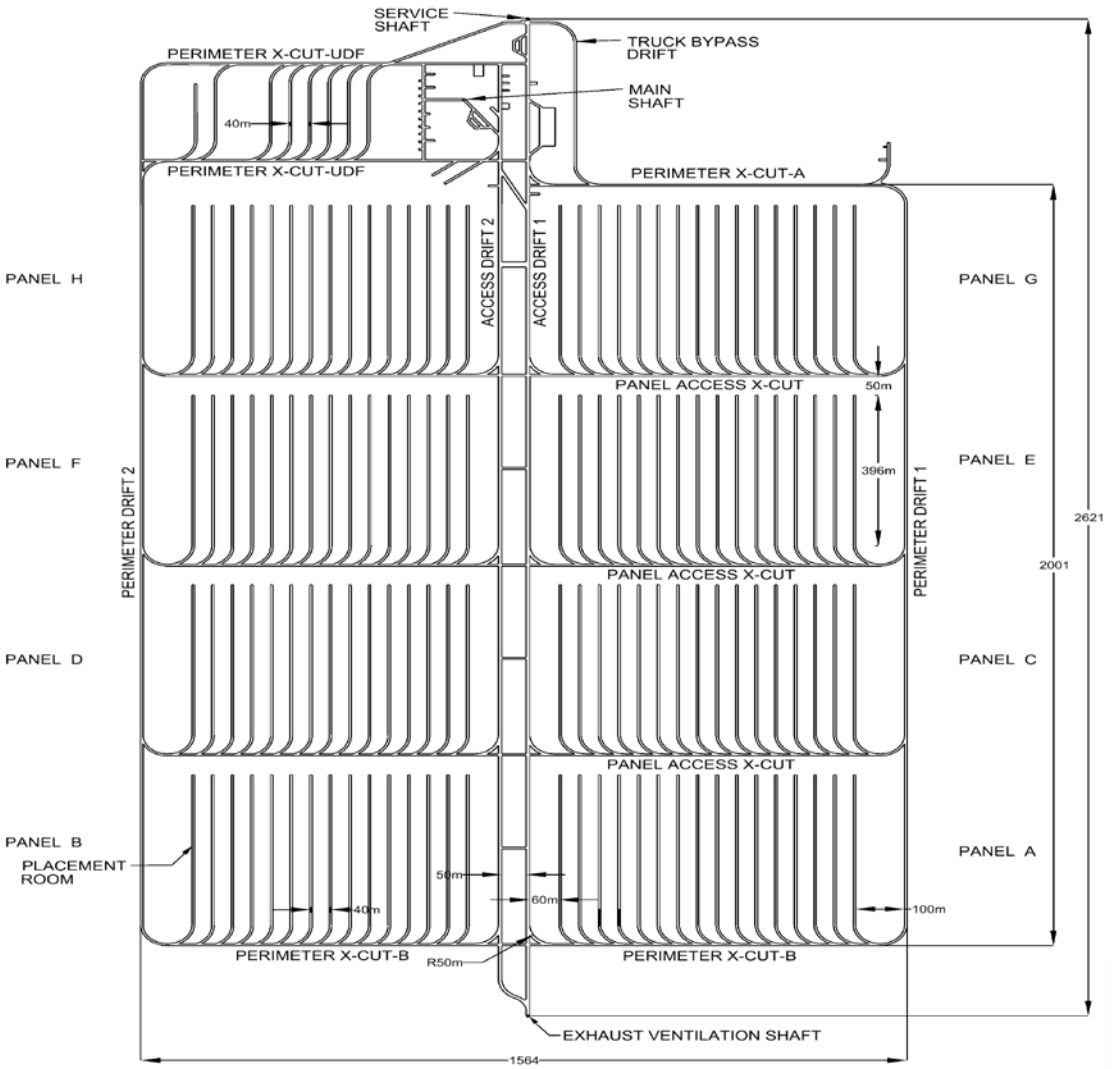
Used Fuel Packaging Plant - Layout

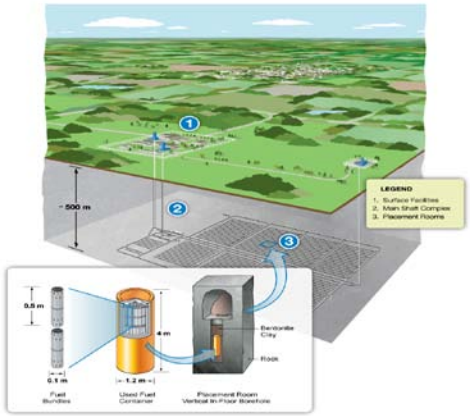
APM Repository Design - Crystalline Rock

- Deep Geological Repository design:
  - Main Shaft (7 m dia.):
    - Payload: 63.5 tonnes
    - Convey: used fuel containers + shielding
  - Service Shaft (6.5 m dia.):
    - Payload: 10 tonnes
    - Convey: personnel (50), equip., waste rock, muck, sealing materials
  - Ventilation Shaft (6.5 m dia.)
  - Placement Rooms (reference design):
    - Copper Containers
    - In-floor Borehole
    - Depth: 500 m
    - Room Height: 5.5 m
    - Room Length: 400 m
    - Room centre-to centre: 40 m
    - Borehole centre-to-centre: 4.2 m
    - Bentonite disks & rings
  - Excavation: Drill & blast (mostly)

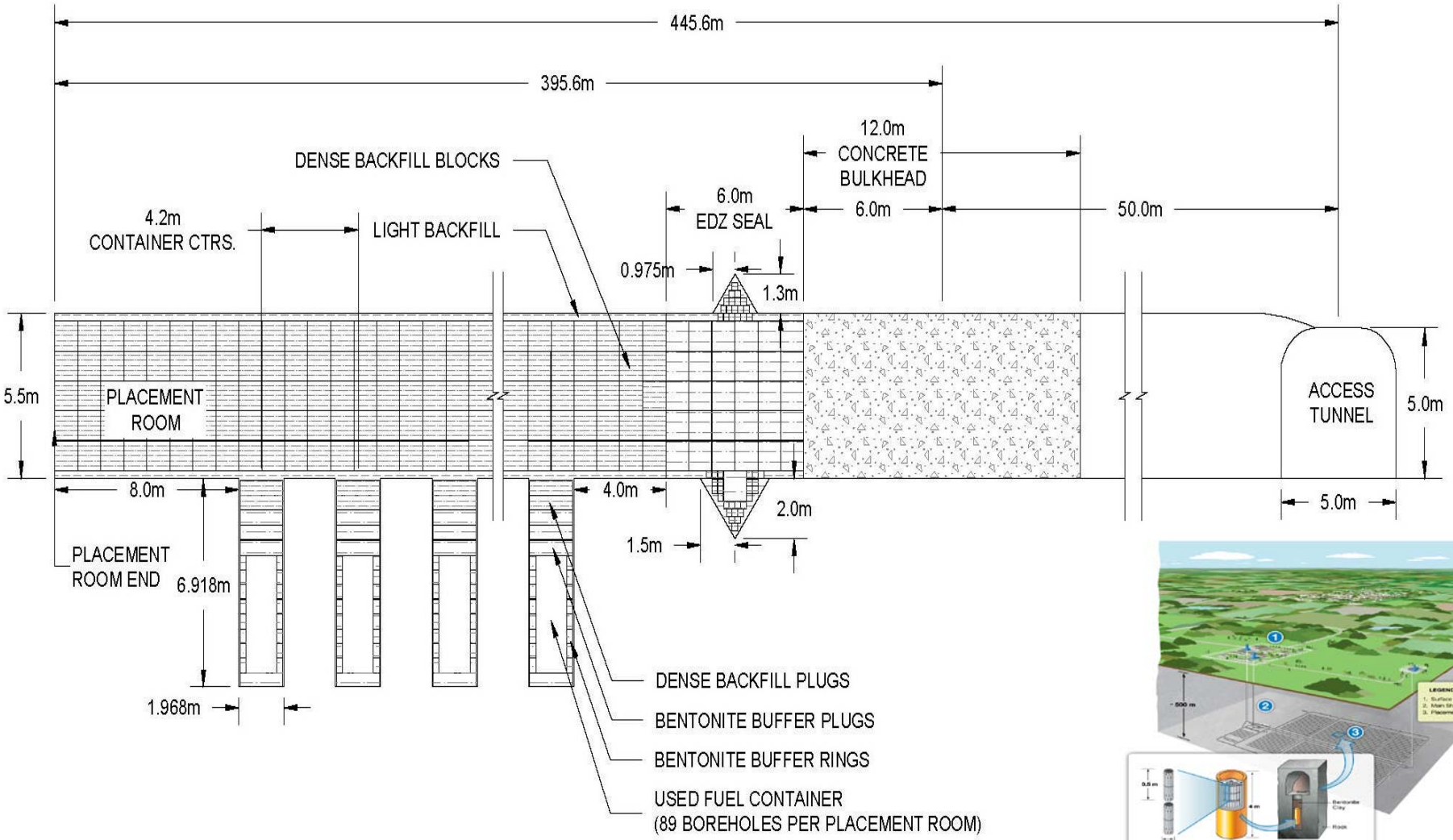


Crystalline Rock – Underground Layout



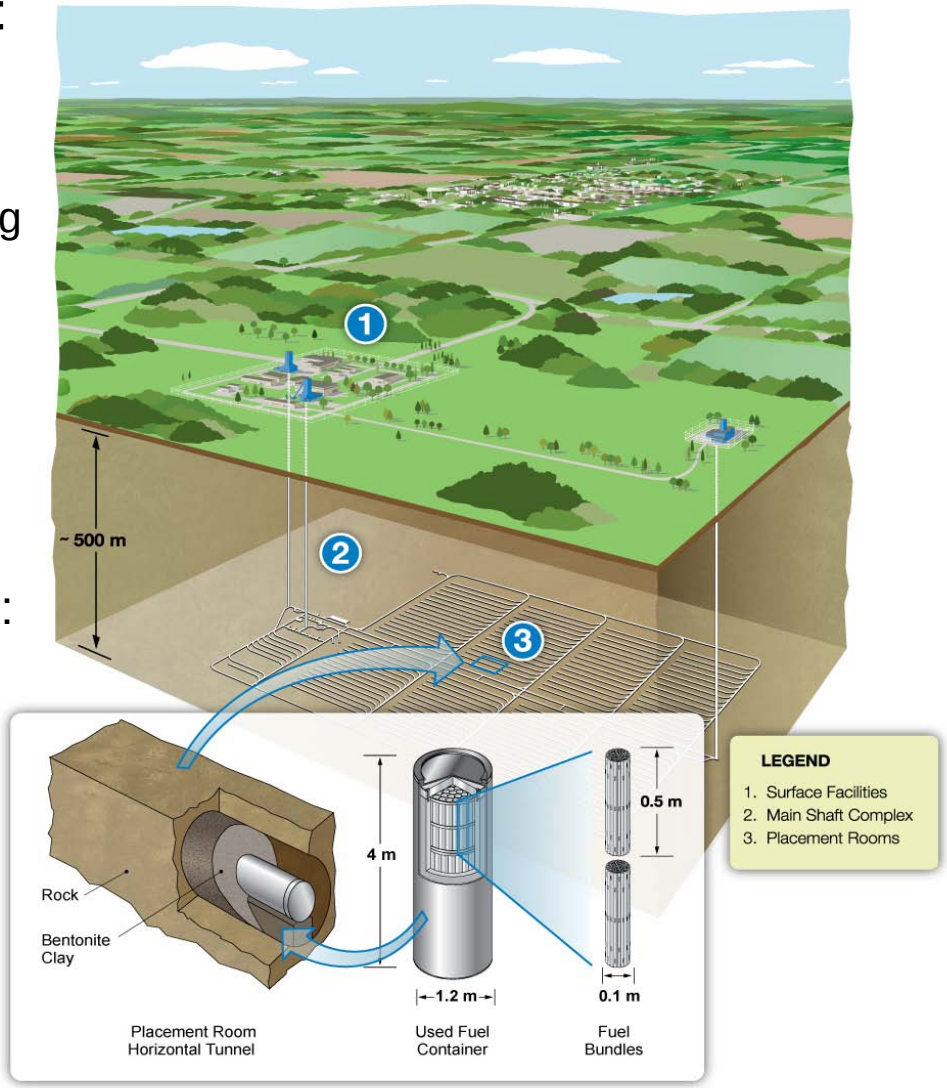


Crystalline Rock – In-Floor Borehole Placement

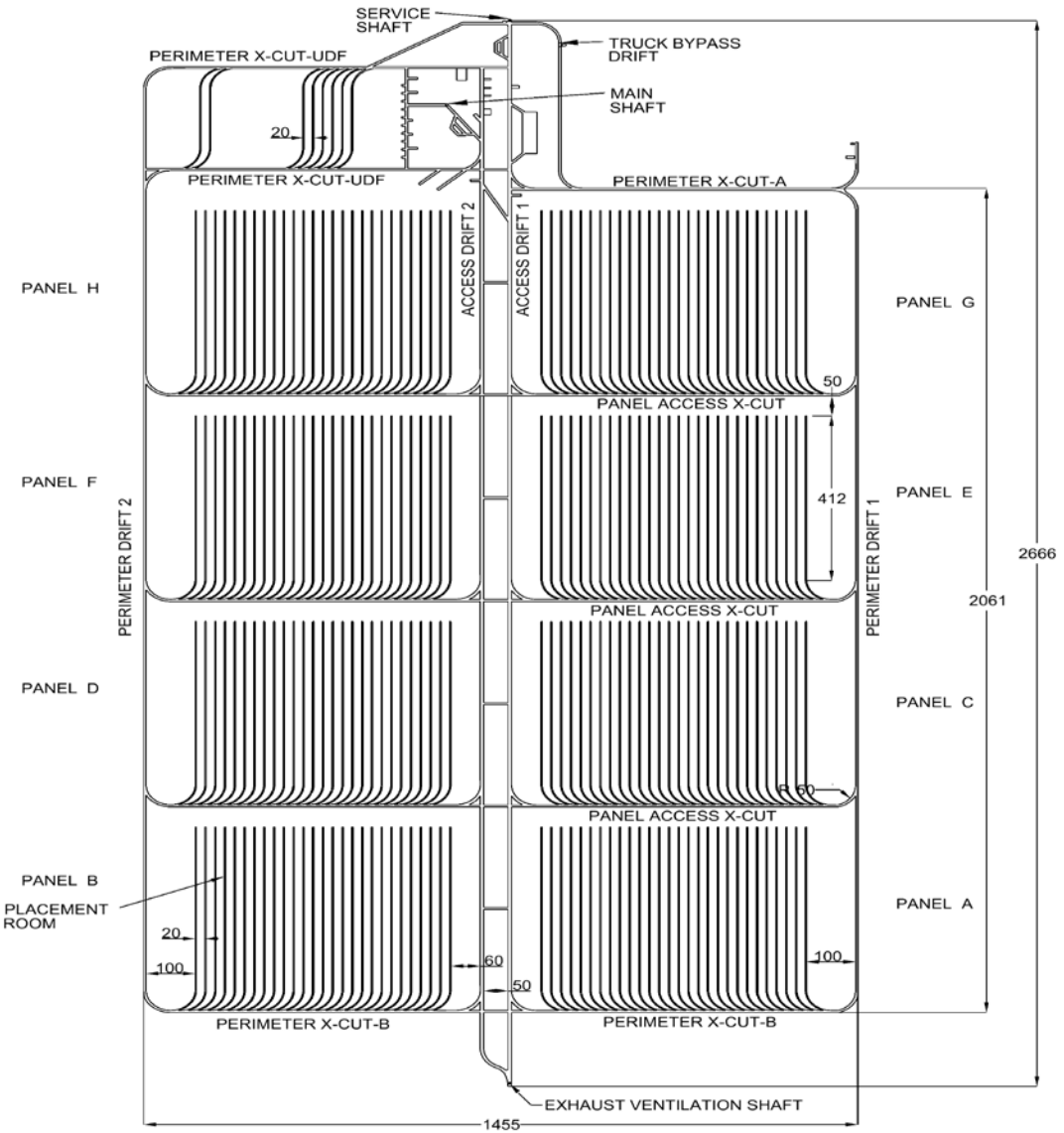


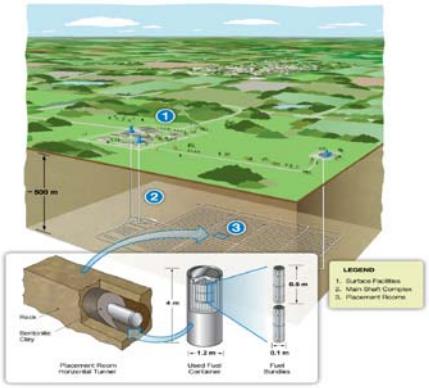
APM Repository Design - Sedimentary Rock

- Deep Geological Repository design:
  - Main Shaft (7 m dia.):
    - Payload: 63.5 tonnes
    - Convey: used fuel containers + shielding
  - Service Shaft (6.5 m dia.):
    - Payload: 10 tonnes
    - Convey: personnel (50), equip., waste rock, muck, sealing materials
  - Ventilation Shaft (6.5 m dia.)
  - Placement Rooms (reference design):
    - Steel or Copper Containers (TBD)
    - Horizontal Tunnel
    - Depth: 500 m
    - Tunnel Diameter: 2.5 m
    - Room Length: 410 m
    - Room centre-to centre: 20 m
    - Bentonite pedestal & pellets
  - Excavation: Tunnel boring (rooms)

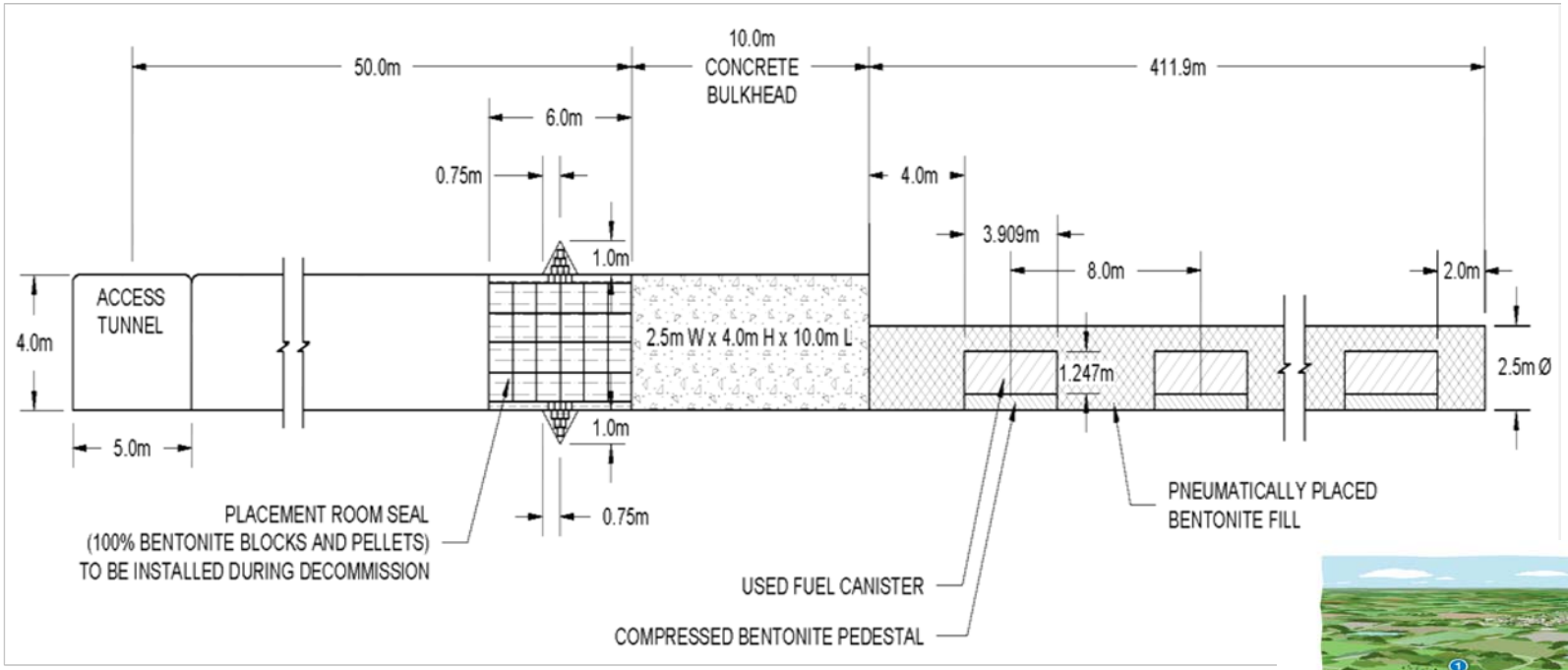


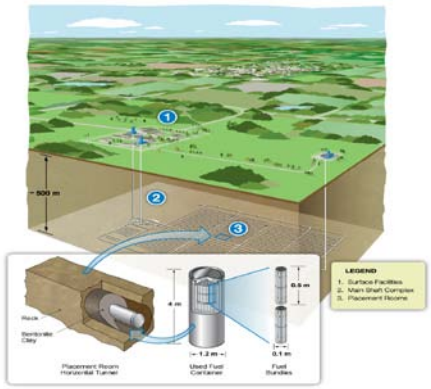
Sedimentary Rock – Underground Layout





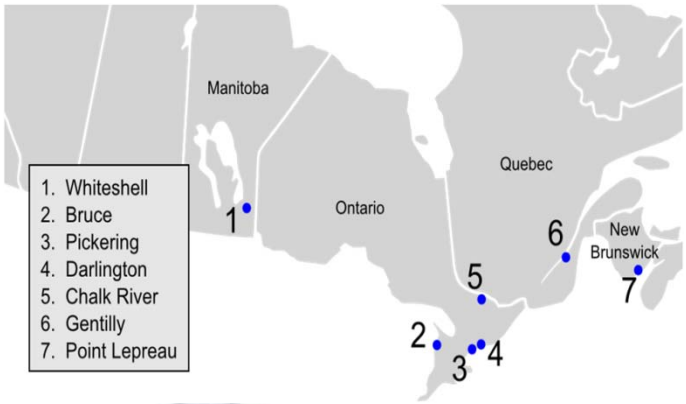
Sedimentary Rock – Horizontal Tunnel Placement

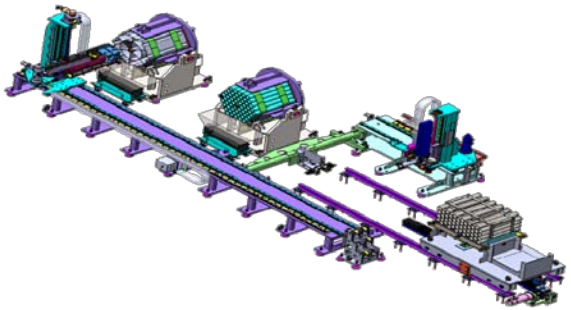


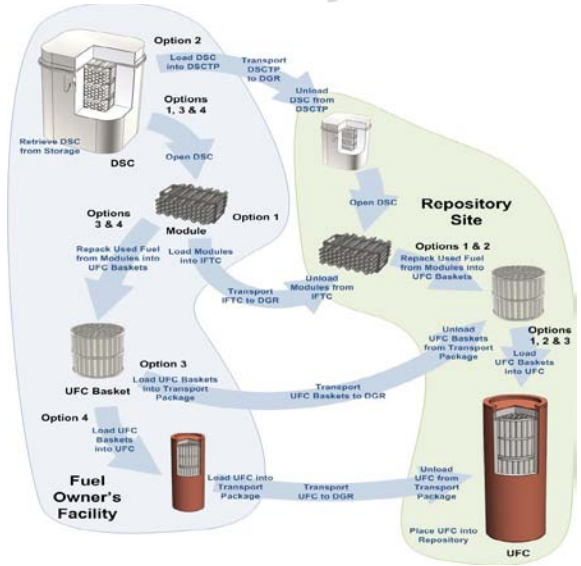


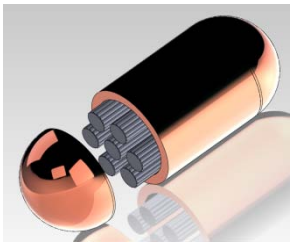
Repository Design Development

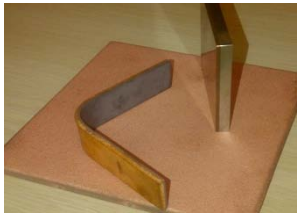
- Advance and optimize reference design of a deep geological repository and associated used fuel transfer and transportation systems
- Work program areas include:
  - Used fuel transfer logistics
  - Container size optimization
  - Corrosion barrier manufacture
  - Container design
  - Used fuel packaging plant design





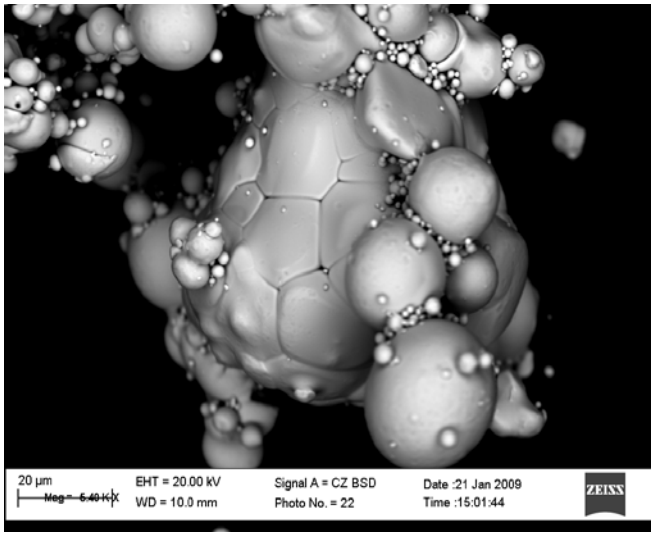


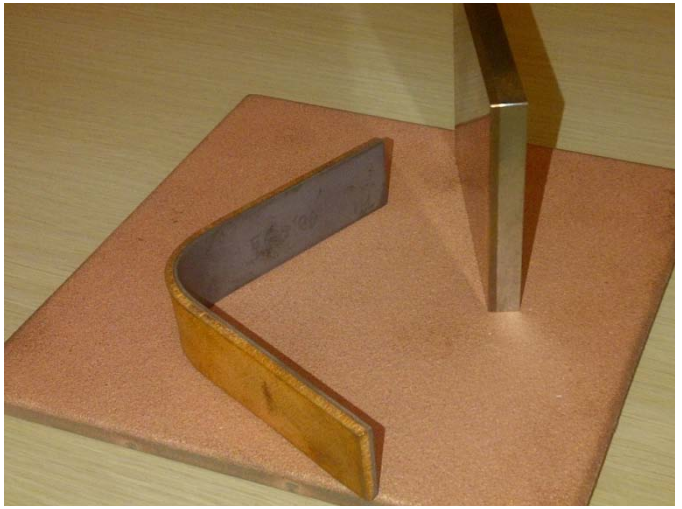




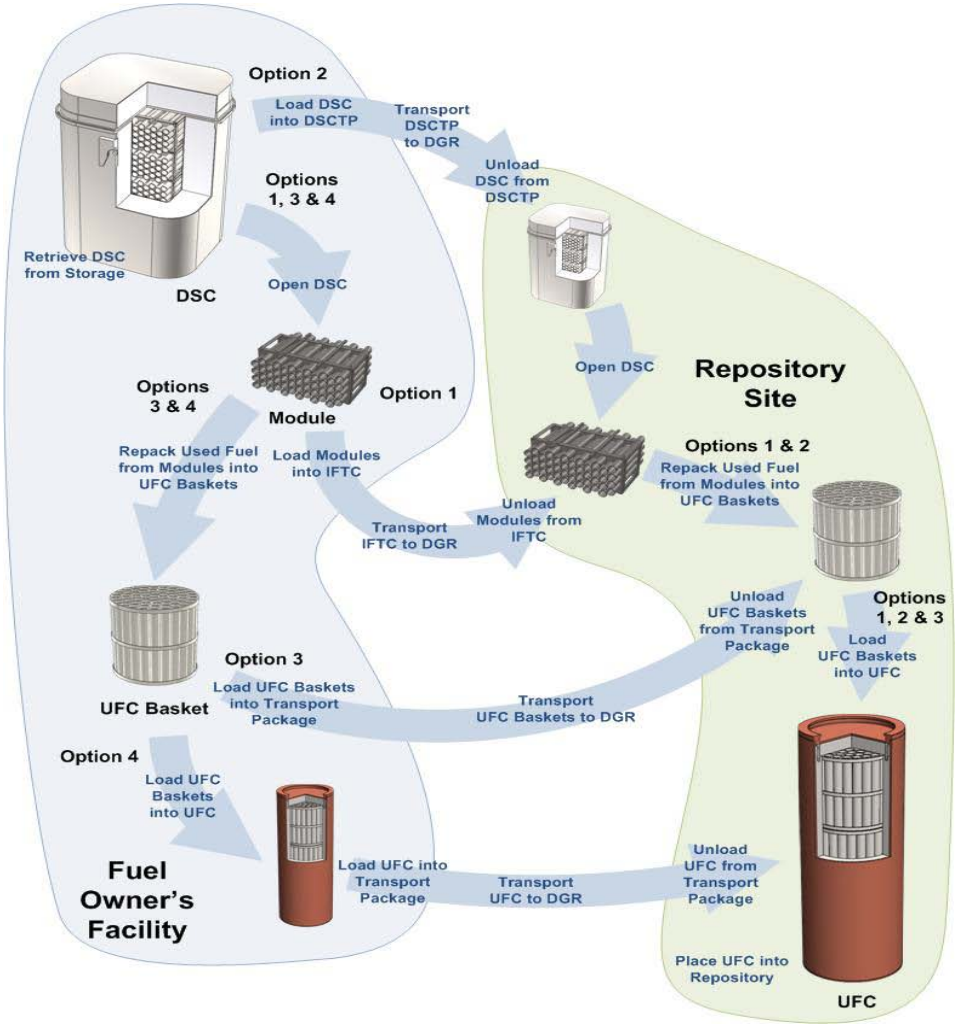
Corrosion Barrier Manufacture

- Reference design of used fuel container:
  - Copper shell (corrosion barrier) + carbon steel inner vessel (structural support)
    - Few mm copper required for corrosion protection over 10^6 years
    - 25 mm copper required for manufacturing & handling
- Alternate design:
  - Cold spray or laser coating of copper powder onto steel vessel
    - Copper thickness & material properties designed to meet requirements
    - More flexibility → container geometry and capacity

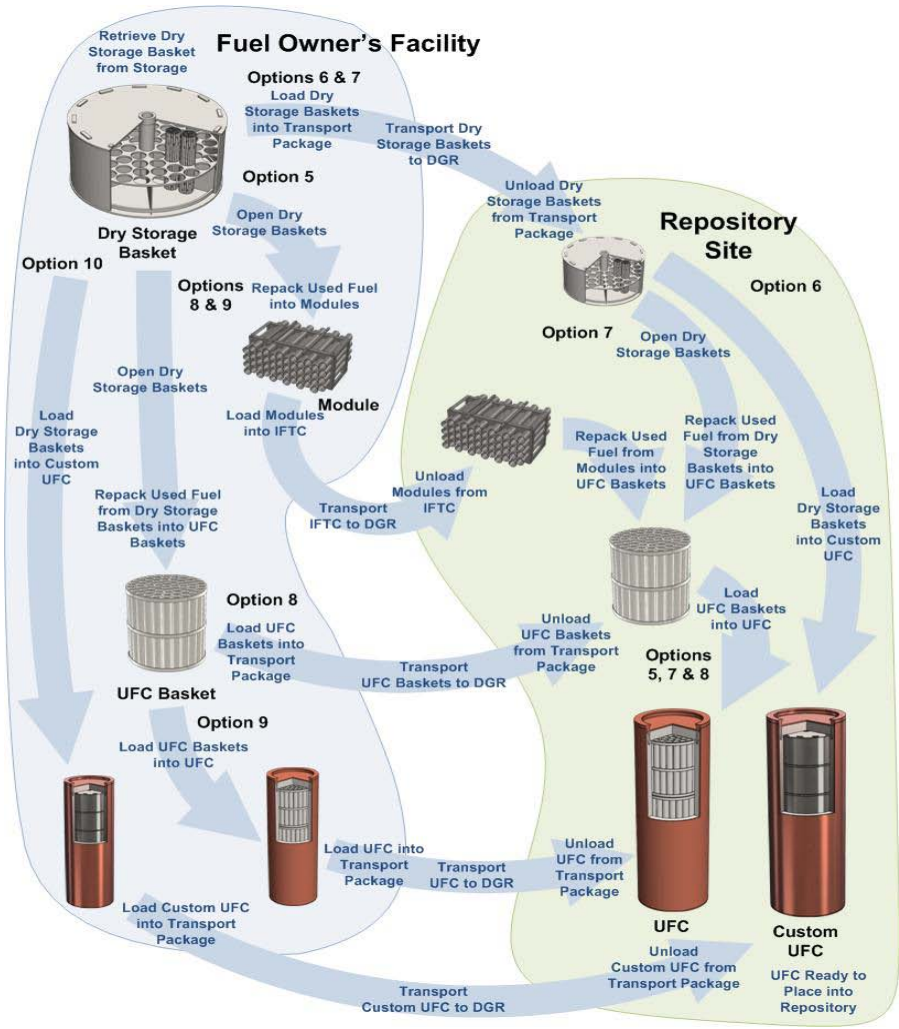




Used Fuel Transfer Logistics – Stations to Site



OPG CANDU Fuel

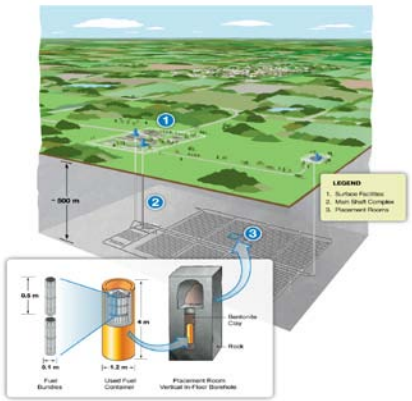


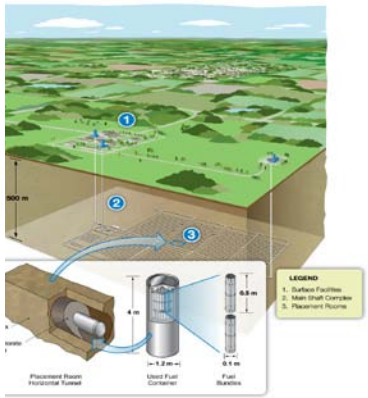
Non-OPG CANDU Fuel

Summary

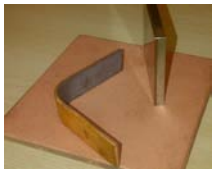
- NWMO is implementing Adaptive Phased Management for long-term management of Canada's used nuclear fuel

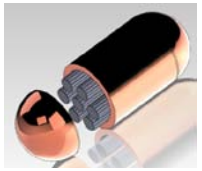
- Plan to complete generic repository design development by 2018
- Studying options for generic conceptual repository designs in potentially suitable host rock formations, e.g.:
  - In-floor Borehole
  - Horizontal Tunnel





- Studying options for used fuel containers:
  - Copper shell + steel insert
  - Copper coating of steel container
  - Steel shell container
  - Used fuel transfer logistics





- Final selection of APM repository designs will depend on optimization studies, safety analyses & preferred site characteristics

- End -