

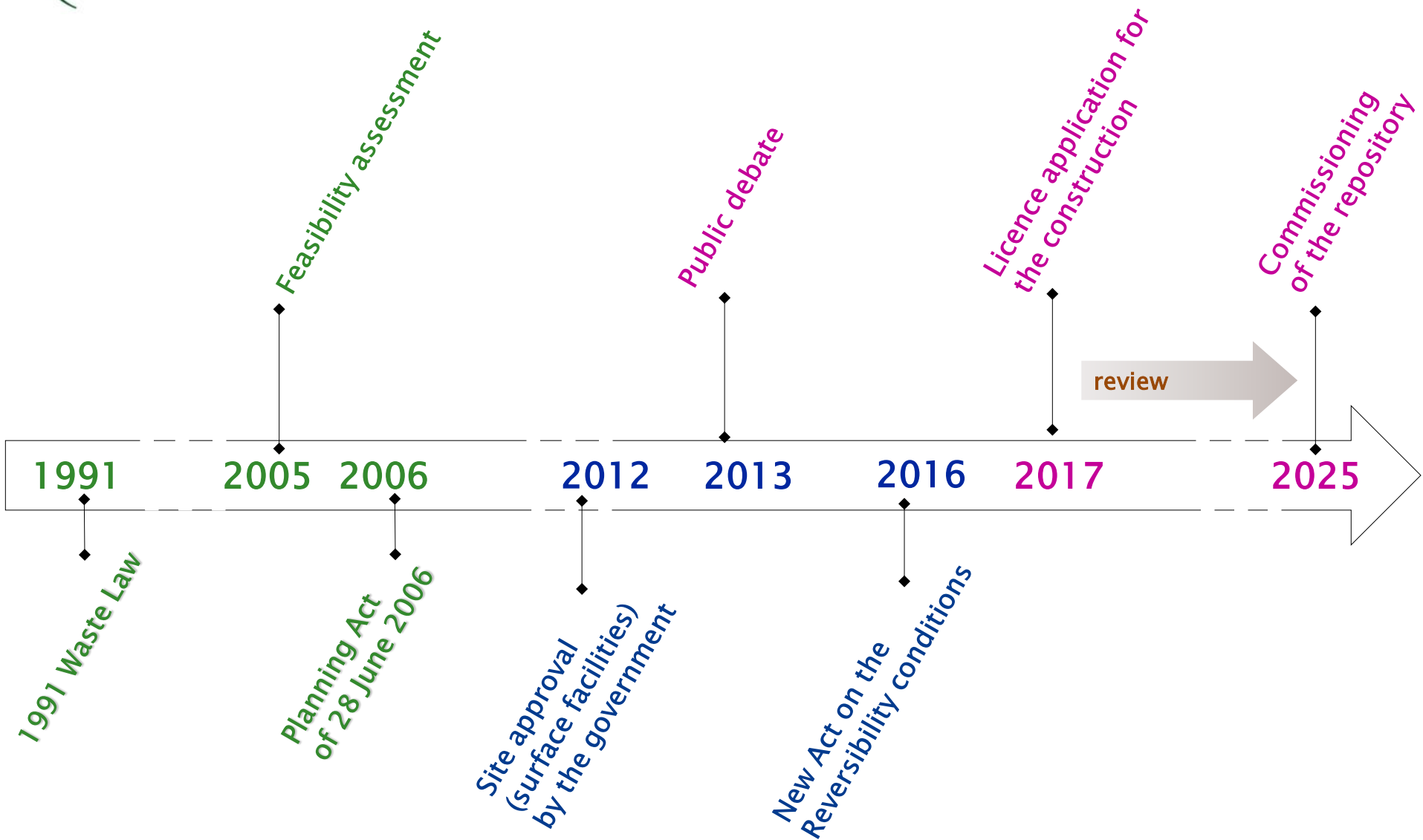


LUCOEX Meeting & Workshop – Aspö HRL General presentation of the CI GEO project

Jean-Michel Bosgiraud

14 May 2014

The Cigéo Planning Act of 28 June 2006



CIGEO = Centre Industriel de Stockage Géologique (Industrial Geological Disposal Centre)

•Waste to be stored in CIGEO Repository

➤ Long Lived (IL-LLW)

- Intermediate Level Long Lived Waste
 - *Great variety of waste types,*
 - *245 000 primary packages – 110 000 m³*

➤ Intermediate Thermal Power (HL-LLW)

- High Level Waste with Intermediate Thermal Power
 - *Research and Military spent fuel and vitrified waste*
 - *6000 primary packages – 800 m³*

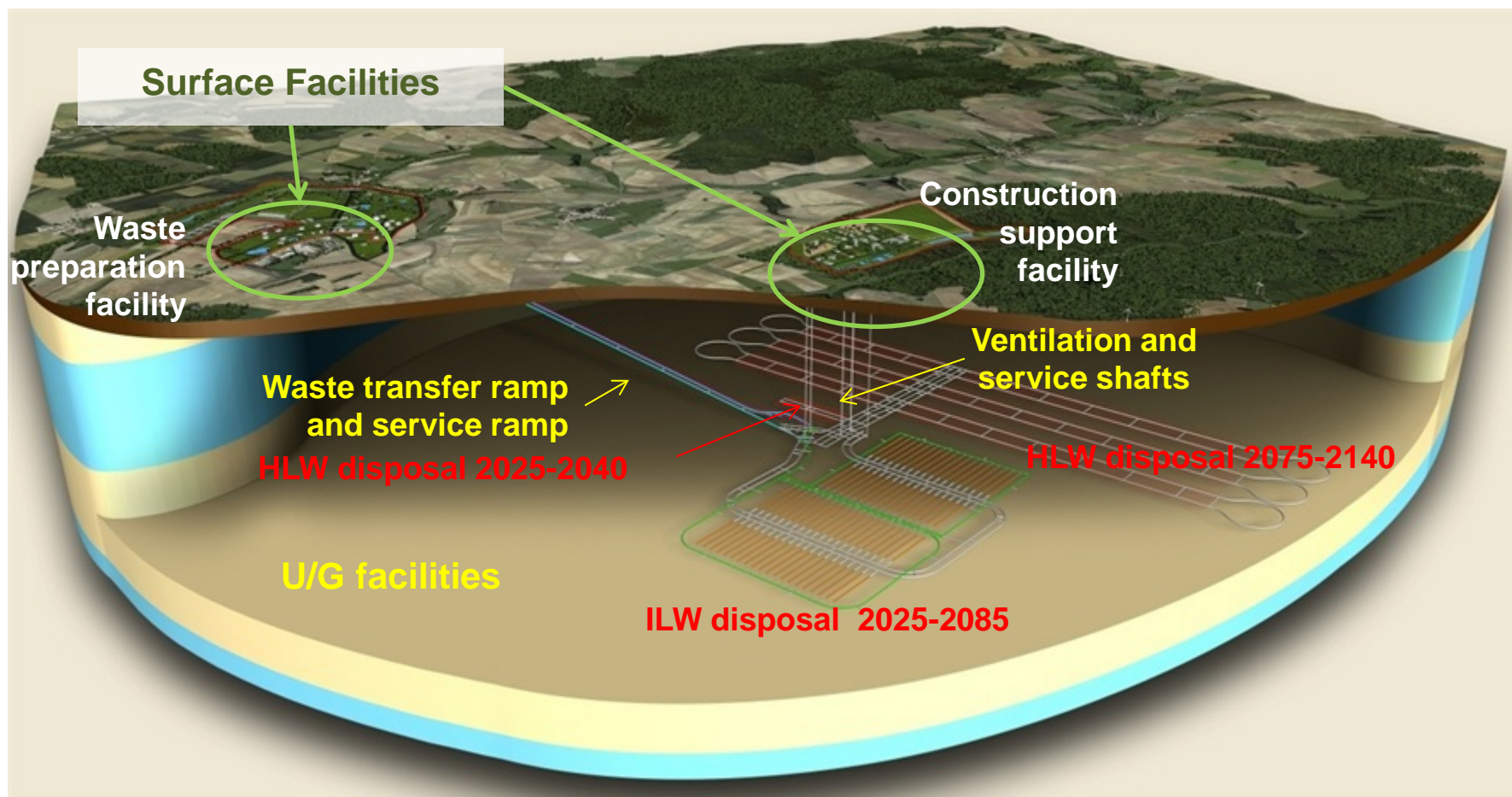
➤ Vitrified (HL-LLW)

- High Level Waste with High Thermal Power
 - *Vitrified waste from spent fuel reprocessing*
 - *To be sent to underground repository after 2075*
 - *57000 primary packages – 11000 m³*

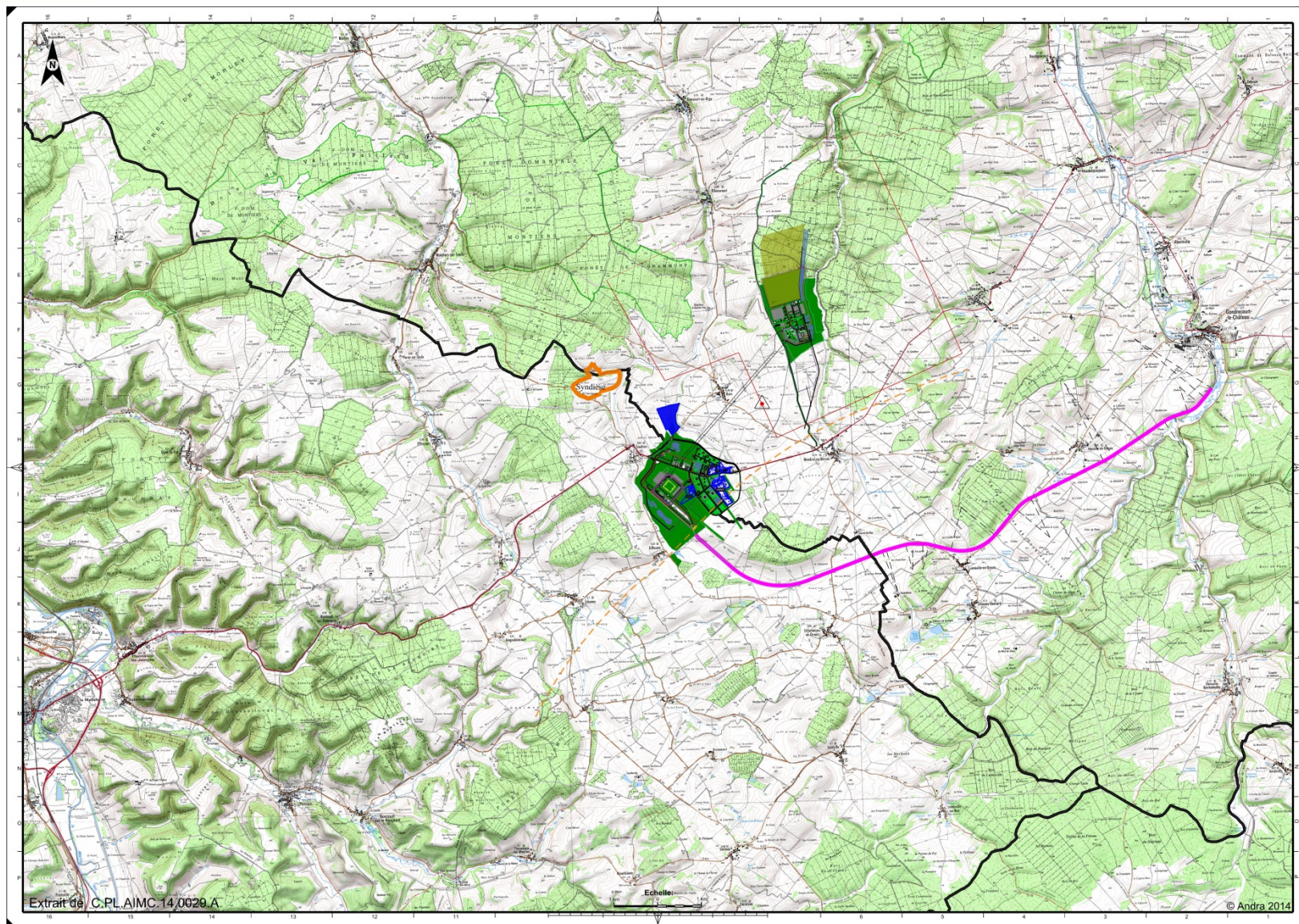
Non-typical nuclear installation, located underground, built and operated over 100 years, dedicated to the waste produced by the existing French nuclear facilities (including the first French EPR now under construction in Normandy).

The Cigéo project

The underground facility is hosted 500 m deep in a thick argillite (hard clay) formation



≈ 120 km of drifts & 160 km of micro-tunnels
 ≈ 10 to 15 km² underground surface (footprint)
 ≈ 8 to 12 million m³ excavated rock



Many types of IL-LLW primary packages



CSD-C standard canister of compressed waste
(hulls & endings)

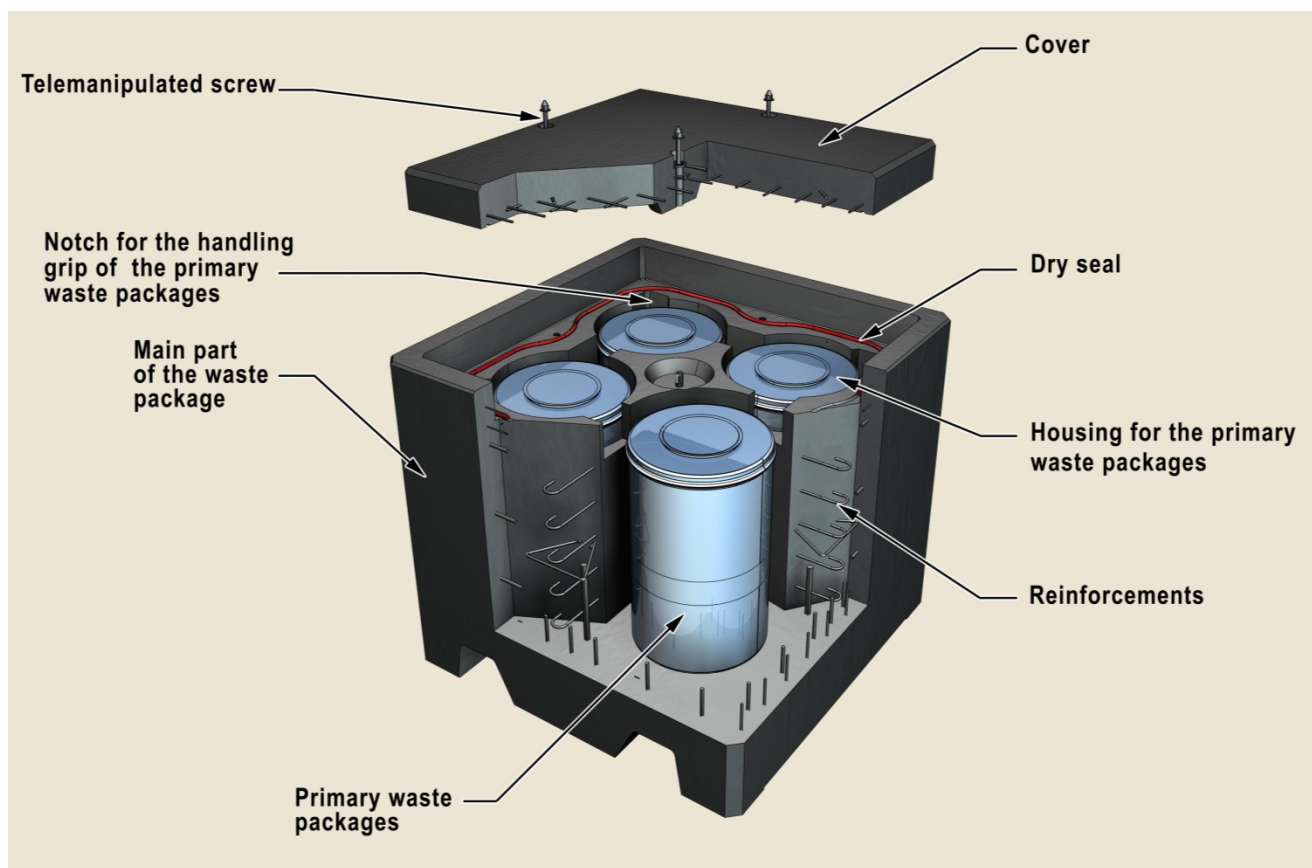


Stainless
steel drum
containing
bituminized
waste

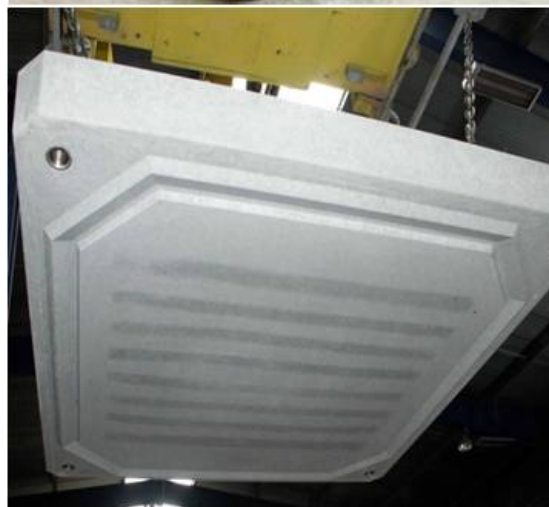
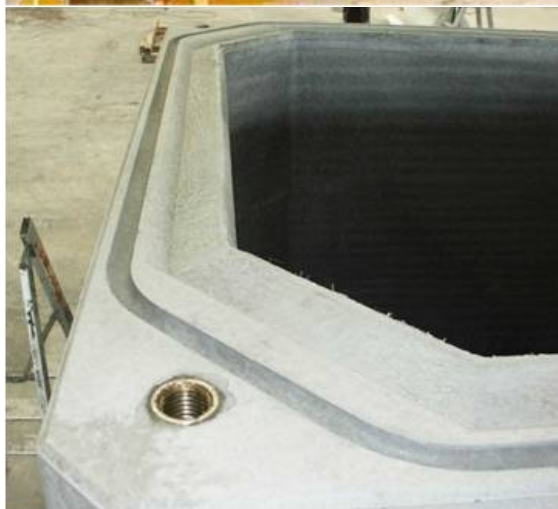
Fiber
reinforced
concrete
matrix



Before emplacement, IL-LLW will be grouped into precast concrete box type disposal containers



Prototype manufacturing of box type HP concrete containers



IL-LLW disposal vaults

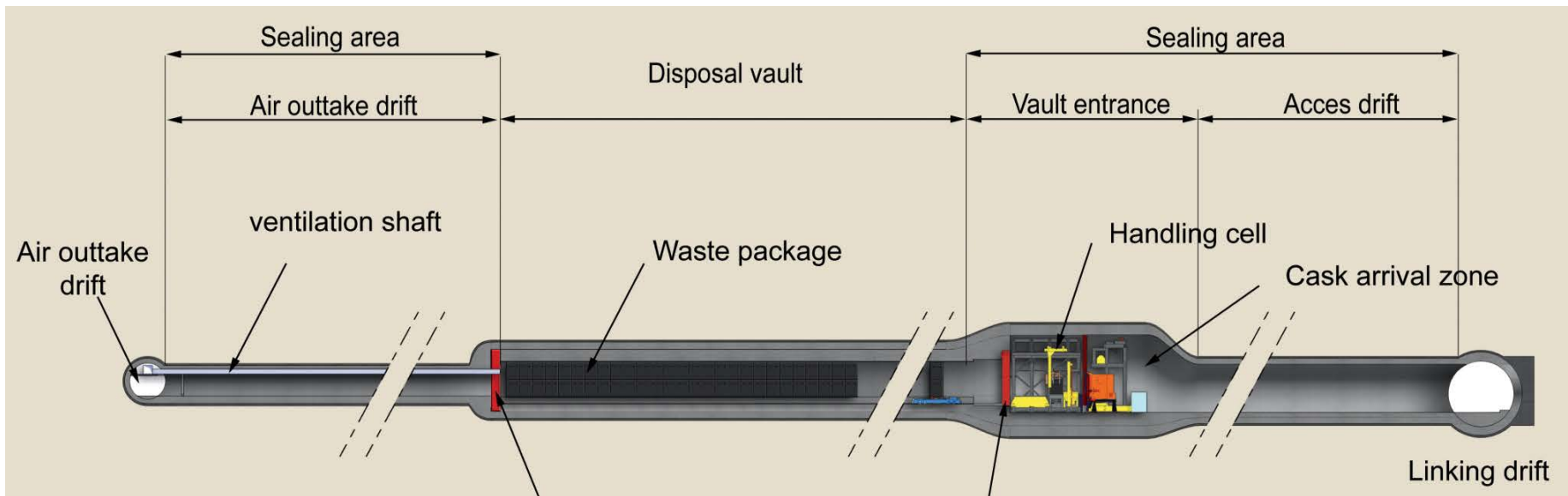
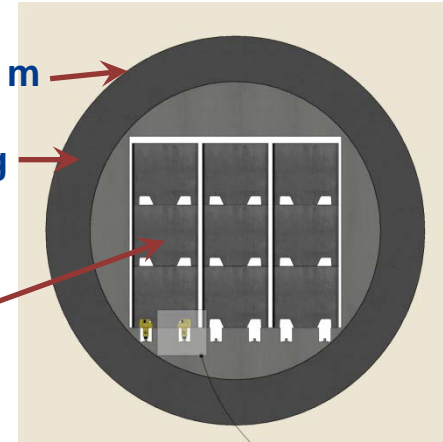
IL-LLW disposal vaults are horizontal tunnels located in the middle of the host clay layer:

- » Thick concrete lining to limit long term deformations;
- » Ventilation of IL-LLW repository cells as long as they are not closed (to allow for H₂ escape).

excavation Ø 10 m

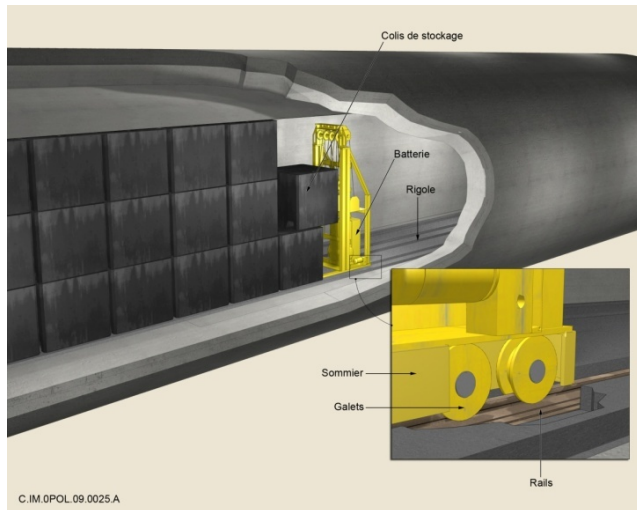
concrete Lining

**IL-LLW
disposal
package**

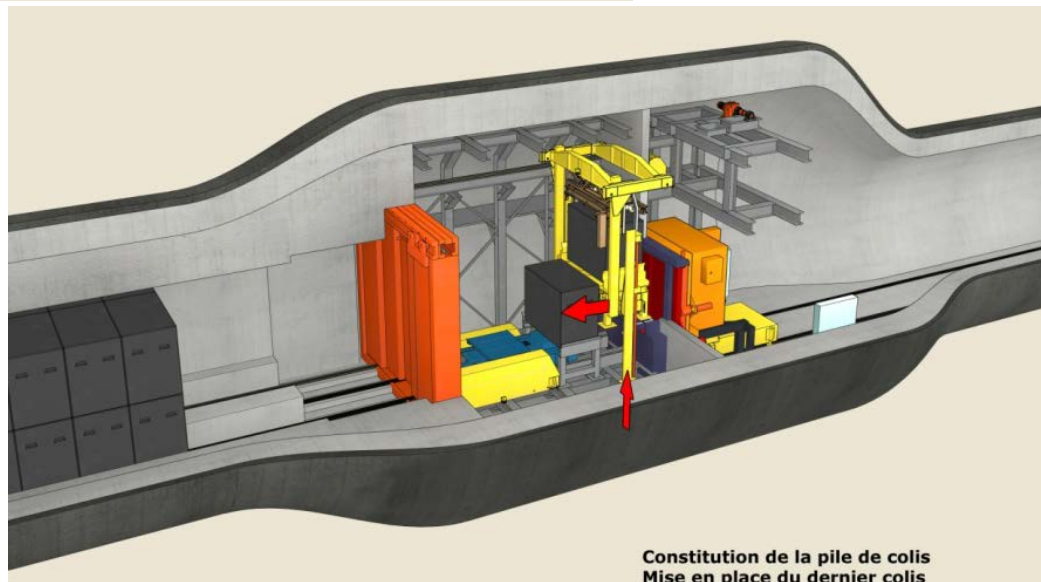
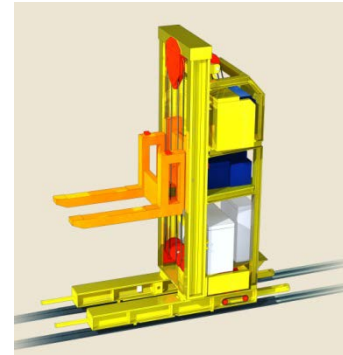


Stacking of IL-LLW in **disposal** vaults

Emplacement/retrieval equipment is being developed and prototyped



**forklift
stacker
technique**

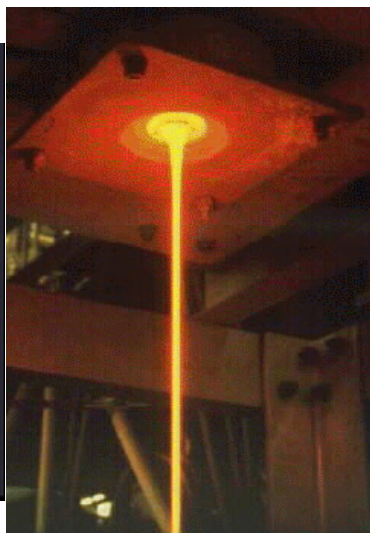
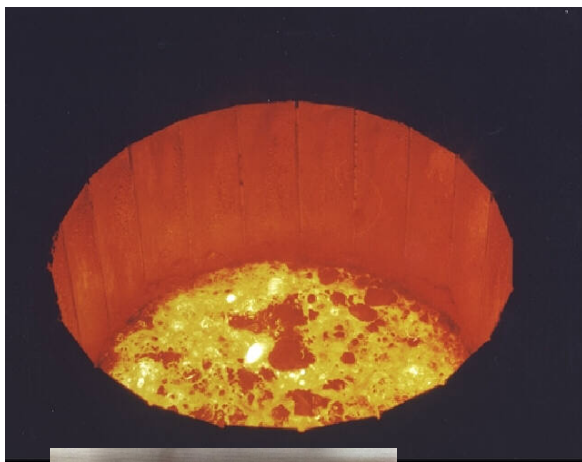


**Pre-stacking
technique**



High or Intermediate Thermal power

Vitrification of the fission products and of minor actinids



AVM container

Final thermal power: $P < 250 \text{ W}$

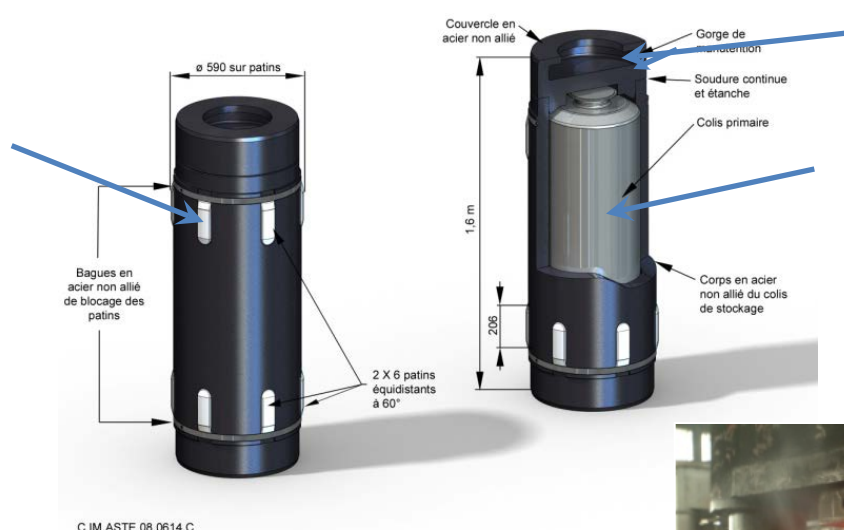


CSD-V containers

Initial thermal power: $P > 2000 \text{ W}$

HL-LLW primary containers placed in thick (~60mm) **steel overpacks** to prevent glass leaching during the thermal phase (~500 years):

Ceramic skids for easy handling



Handling Interface

Vitrified HLW Stainless Canister

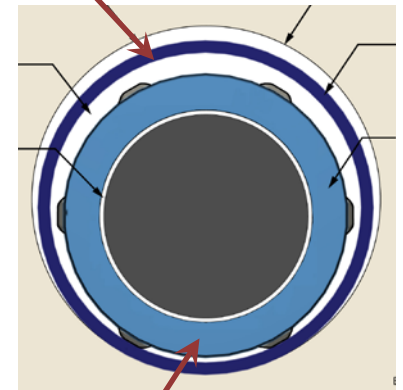
Fabrication of steel overpack by the « pierce & draw » method



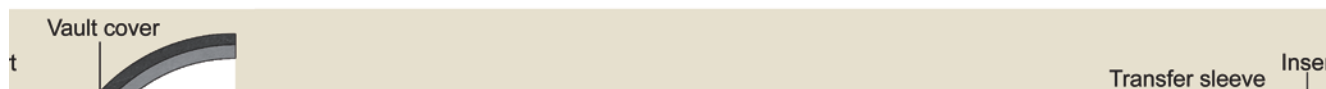
HL-LLW will be disposed of in steel lined horizontal micro-tunnels:

Excavation
Ø 0,75 m

Steel sleeve



Steel overpack

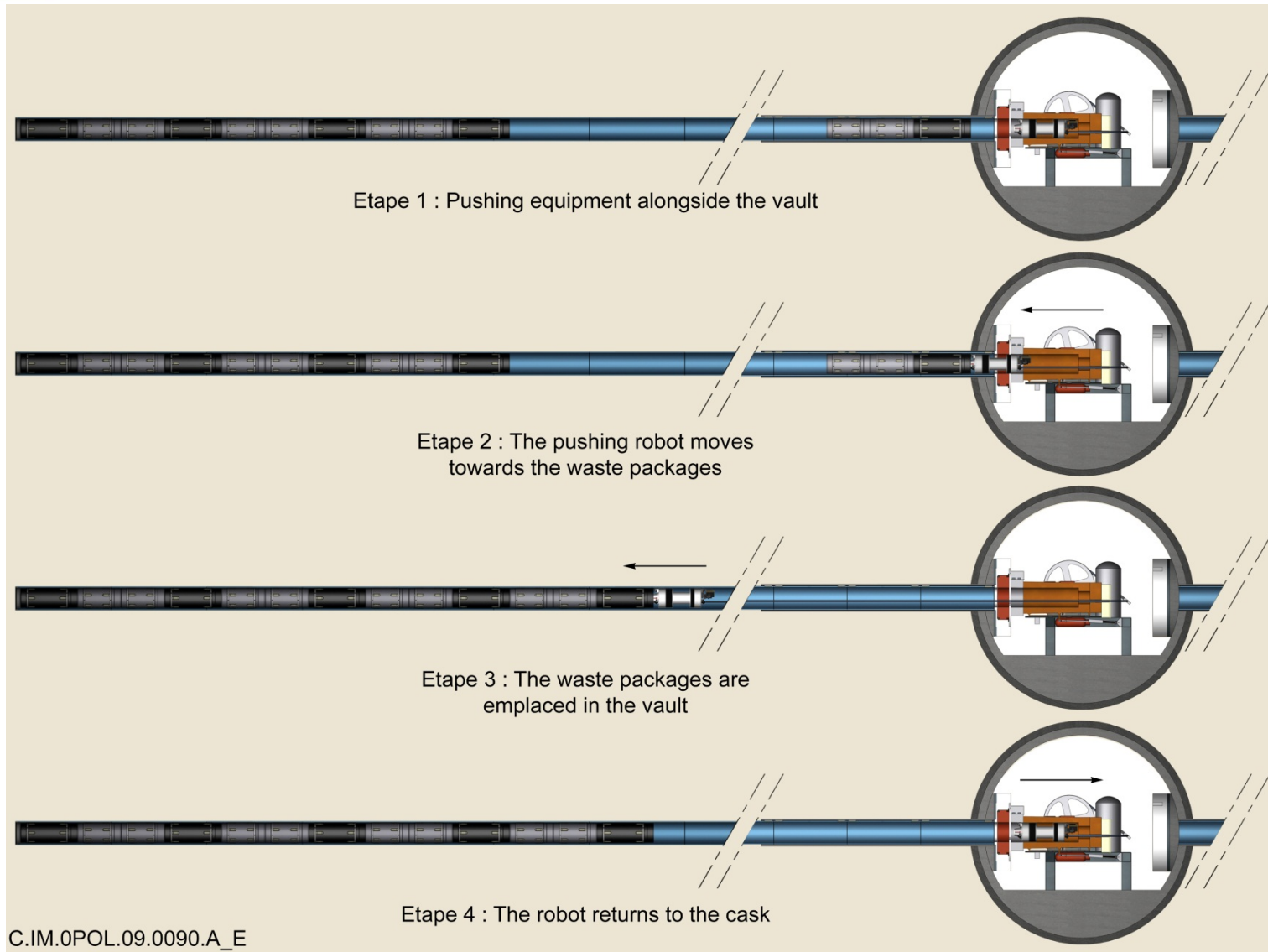


HLW horizontal cells drilling & casing tests

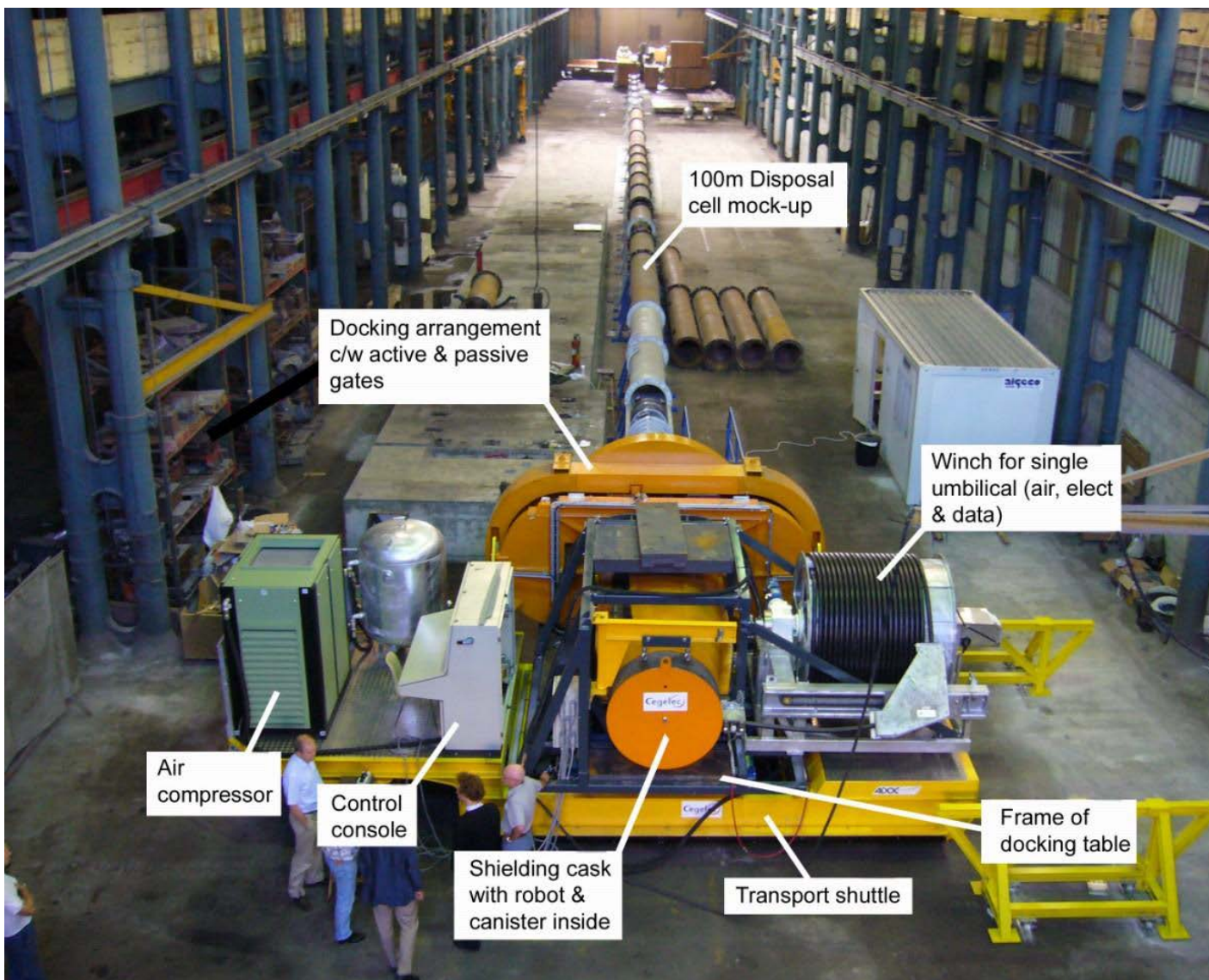
- Micro-tunneling (TBM) machine ,
- 102m long – 75cm D borehole drilled & cased in July 2012,



HLW emplacement equipment : Example of sequence



HLW emplacement / retrieval equipment prototype test



Most dimensioning criterion:

- Temperature of clay should never exceed 100°C
- Temperature criterion in clay is 90°C to include safety margin

This criterion impacts directly:

- Distance between packages within disposal cell
- Distance between disposal cells
- Compacity of storage, hence its architecture and overall footprint

→ A potential extension of the interim storage period (hence of the thermal decay) of the HL vitrified waste packages may reduce the repository underground footprint and the excavated volume of rock for HL vitrified waste.

- **Principle :**

- Access for waste transfer to underground facility to be used only for nuclear activities, not for non-nuclear construction activities

- **Constraints:**

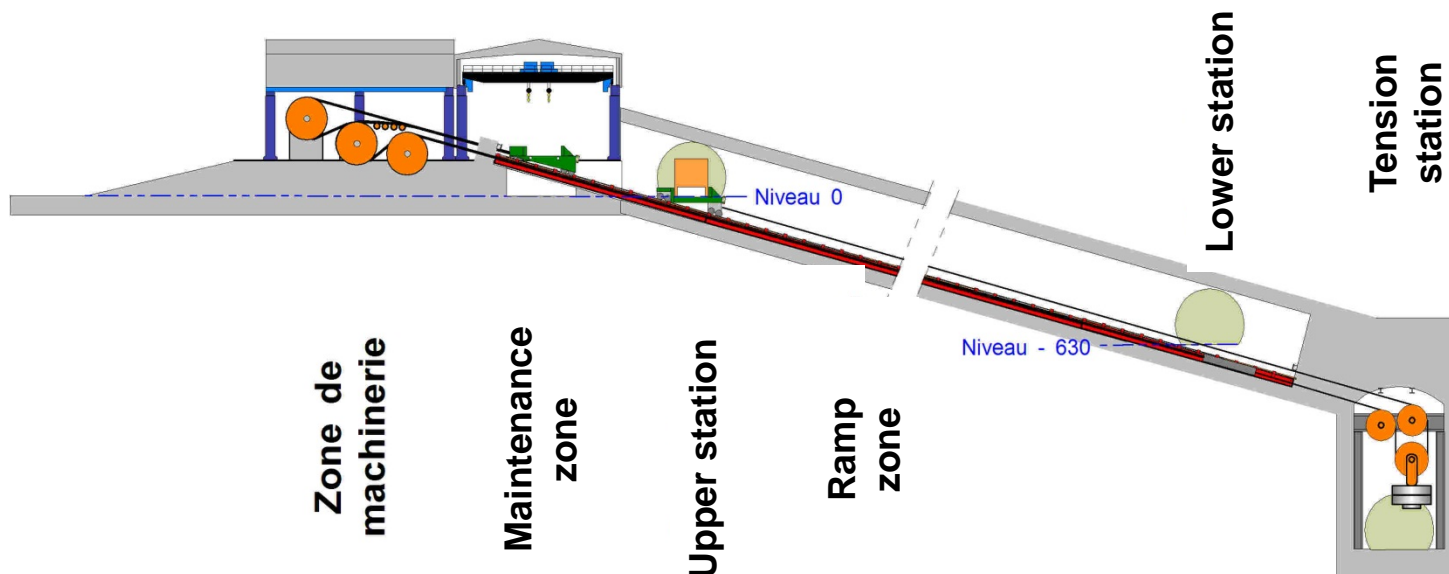
- Heavy loads :
 - Up to 120 tonnes for ILW waste, including radiation protection cask
 - Up to 45 tonnes for HLW waste, including radiation protection cask
- Some ILW packages (bitumen) are very sensitive to heat
- Need ~ 10 trips of waste per day

- **Operating Safety Issues:**

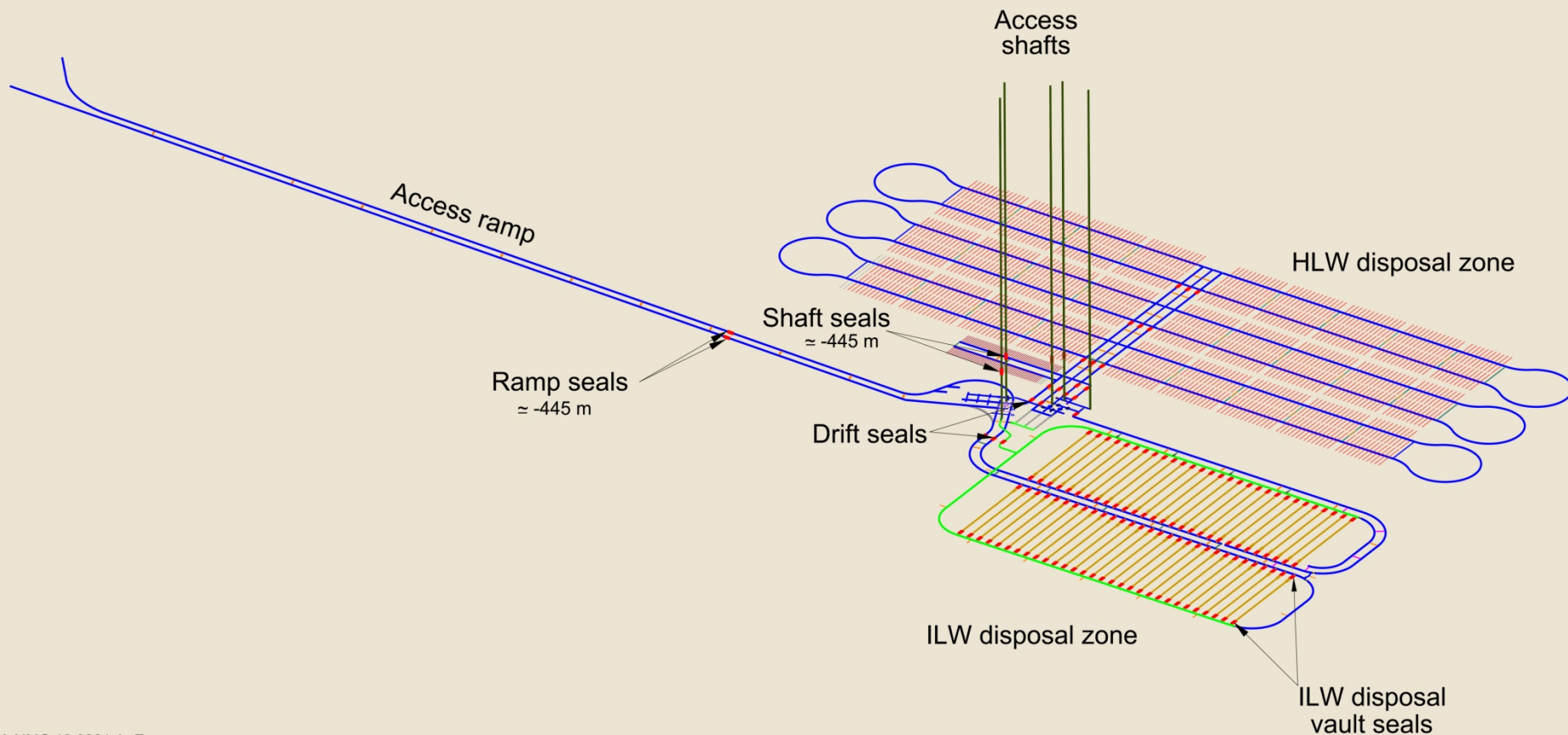
- Risk of contamination caused by
 - Mechanical shock
 - Fire (which could be initiated by a shock)

Transfer of radioactive waste by ramp and cable car

- **Extrapolation of existing technology**
 - ❖ Technology exists even for very high loads
 - ❖ Emergency braking is easier than with a vertical shaft or a transport truck
- **Advantages**
 - ❖ Favourable for fire issue (limited source of fire in ramp, low thermal load in ramp)
 - ❖ Emergency brakes can be tested & qualified easily
- **Andra's reference solution**



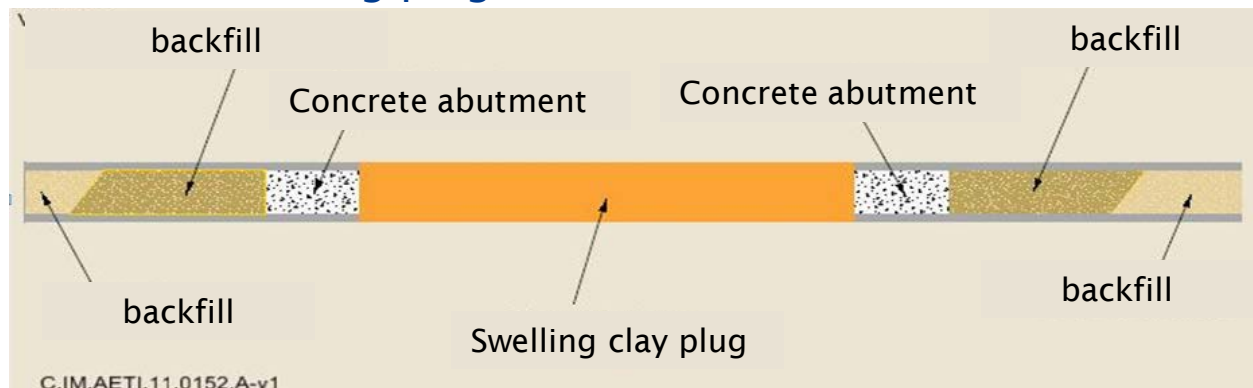
Closure of the Cigéo Repository by Seals - Positioning



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Sealing and backfilling of access shaft , horizontal drift or LL-LLW disposal vault

Reference: Sealing plug



Option : Hydraulic cut off the Excavation Damaged zone (EDZ)

