



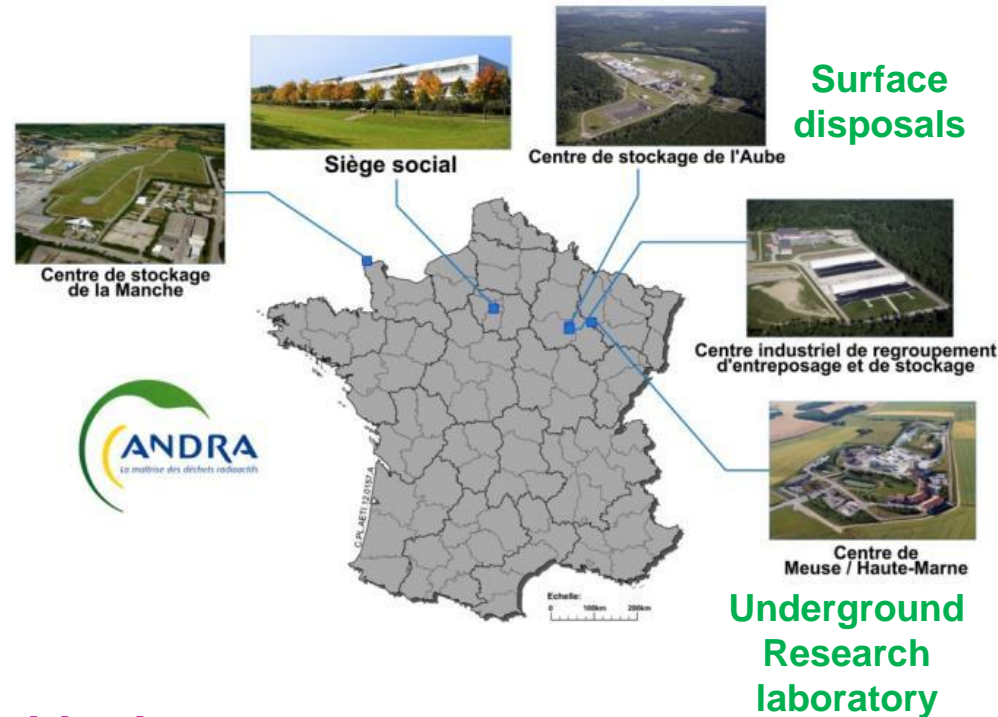
# Physical protection Specificities of a Deep Geological Disposal : The Case of the French Project Cigéo

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Nuclear Material and Nuclear Facilities

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- ◆ Public organization created in 1991 (law of the 30th of December 1991)
- ◆ ~ 650 staff
- ◆ 335M€ budget in 2016
- ◆ Under the supervision of the ministries in charge of energy, research and the environment
- ◆ Independent from waste producers



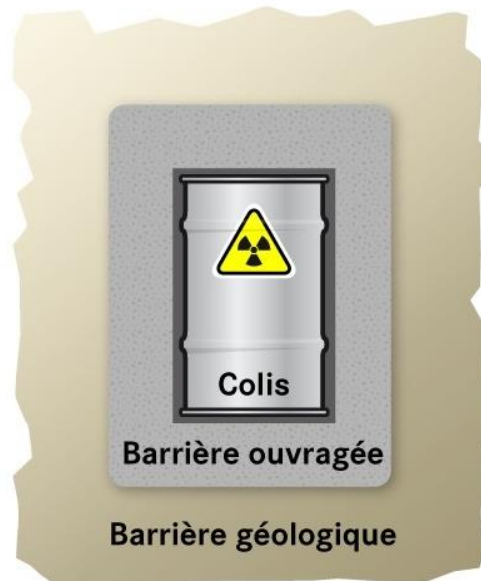
## Its general task and mission defined by law

*Design, implant, build and manage radioactive waste storage and disposal centers in order to protect present and future generations and the environment from the hazard associated with this waste, with respect to the long term perspectives of waste production and management, and, to these ends, carry out the necessary studies*

# Why a Geological Disposal ?

- Protect humankind and the environment from hazardous waste on very long time scale (geology vs society) – 500 m depth

1. Waste package
2. Engineered barrier
3. Geological formation  
(Clay)

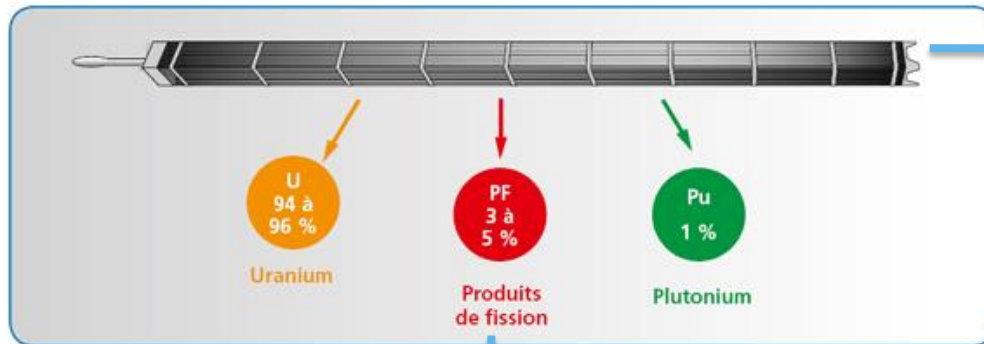


Confinement of  
radioactivity for several  
tens of thousand years

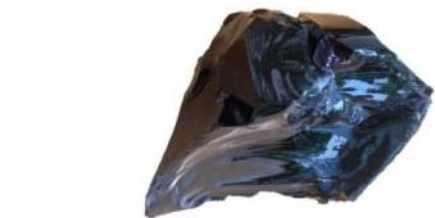
- Prevent undue burden on future generations (the generation that benefited from nuclear energy bears the costs of the management of the waste produced)

# High Level (HLW) and Intermediate Level Long Lived Waste (ILLW) to be Disposed of in Cigéo

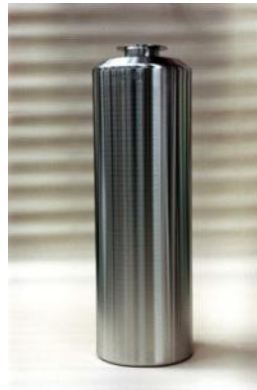
## 1 - Waste issued from irradiated fuel treatment



Hulls and end pieces (ILLW)



Vitrified fission products and actinides (HLW)



## 2 – Operational and dismantling waste from NPP and other facilities (ILLW)



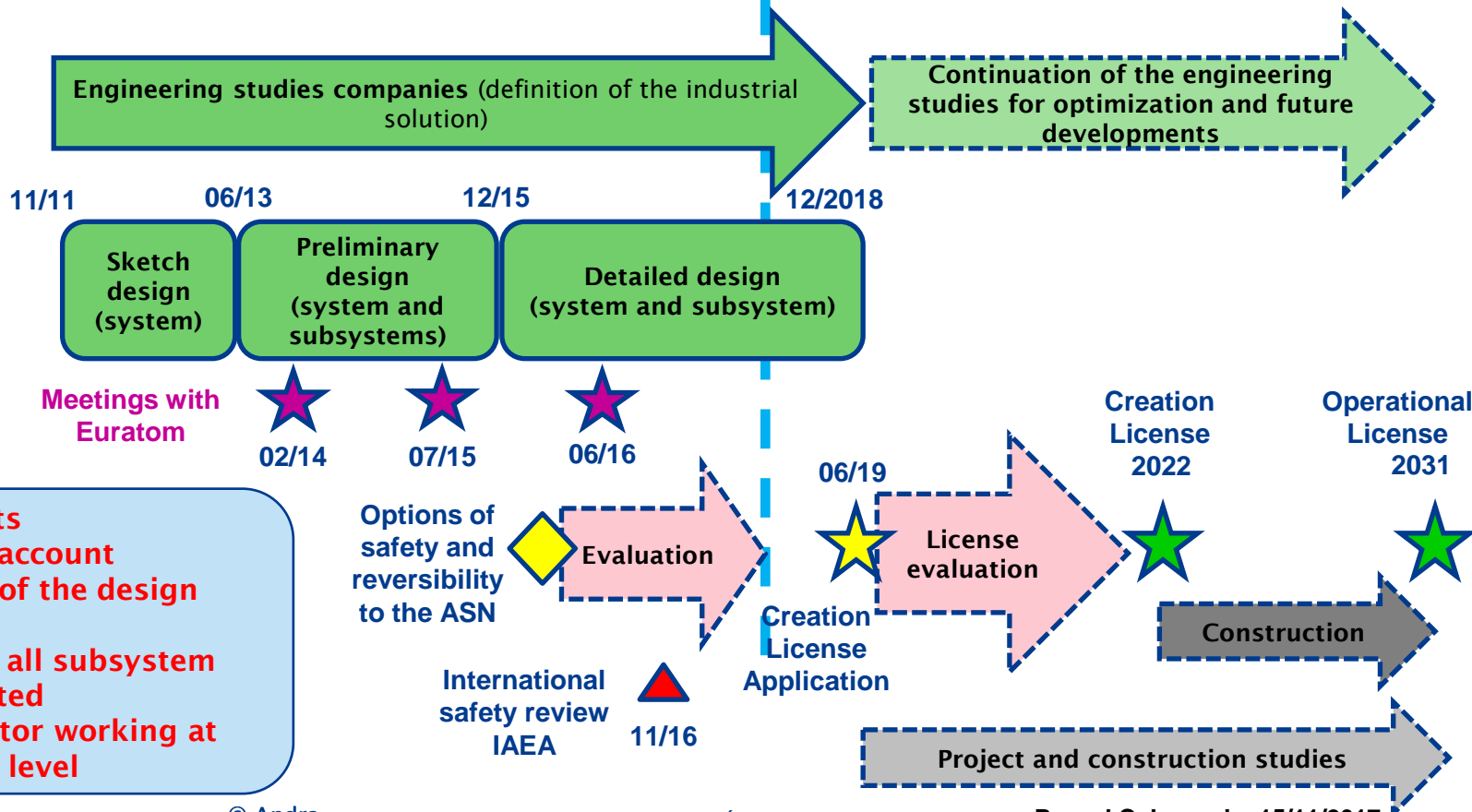
**Projected volume of Waste** : around 75 000 m<sup>3</sup> of ILLW (180 000 packages) and 10 000 m<sup>3</sup> of HLW (60 000 packages)

All the waste to be received in Cigéo is considered to be **“conditioned waste”**.

◆ It represent 99 % of the overall French waste activity but only 3 % of the volume.

# The Development Schedule

**Andra's studies since 1991** : host rock and feasibility (URL), operational and long term safety, environmental assessment, industrial objectives and requirements, cost estimations, specific engineering studies (packages, controls...), compliance to regulations...

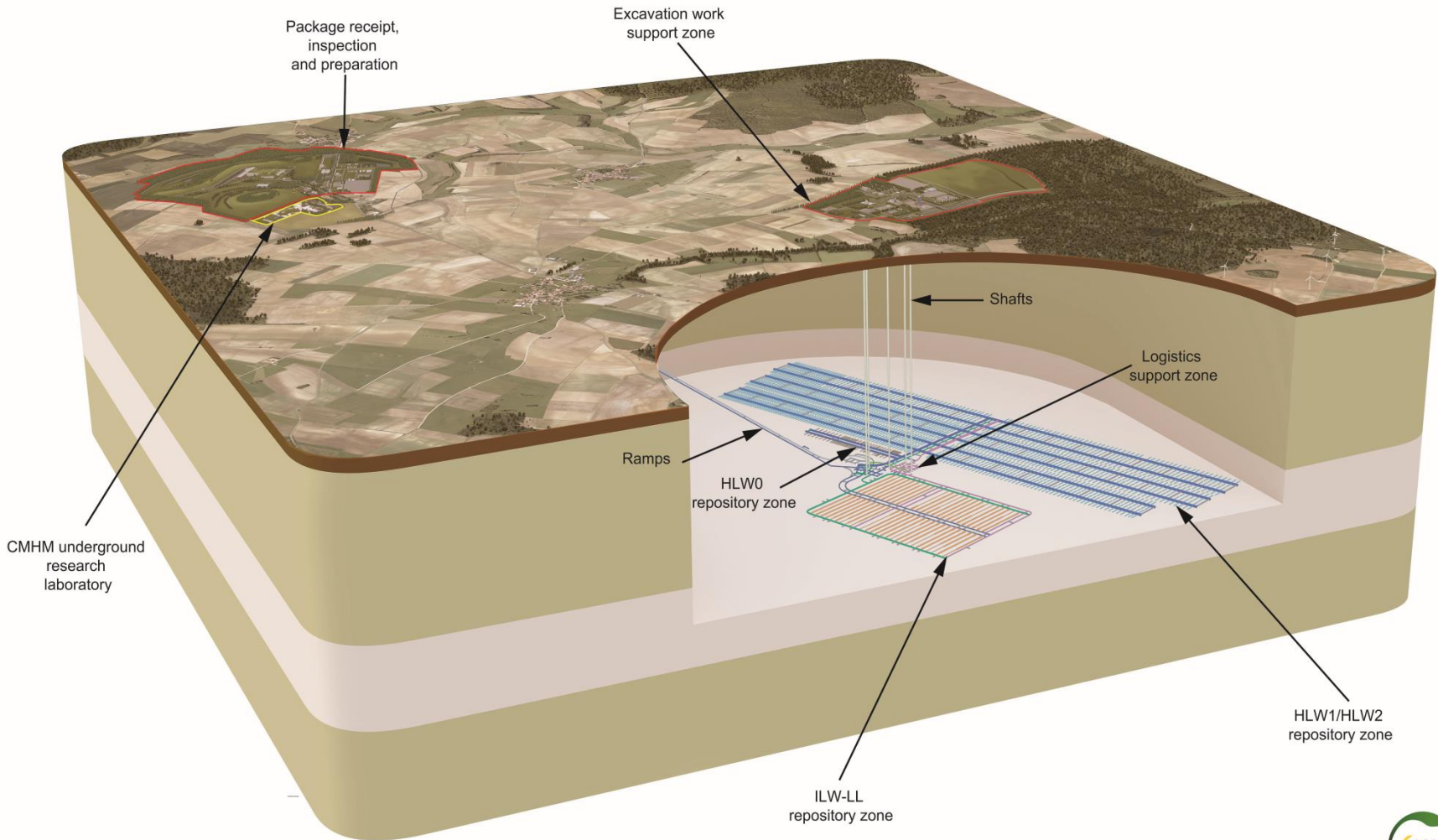


**Security aspects are taken into account from the start of the design studies:**

- studies for all subsystem
- one dedicated subcontractor working at the system level



# The Cigéo Facility – Two Sets of Surface Installations Connected to the Underground Disposal



Structure not to scale.  
Dip of the geological formations not represented.

# Provisional Delivery and Declaration Terms

Waste packages are stored at sites operated by Andra, CEA and EDF.

The first waste packages will be shipped in time for Cigéo's commissioning (pending approval of its creation licence) .

Subsequent shipments will occur throughout Cigéo's service life (mainly from La Hague, Marcoule and Bugey):

- ◆ **Train is the preferential option**
- ◆ **Road will be possible**

Waste generators define the provisional shipping schedule as well as the technical conditions for delivery (rail and/or road).

**Flexible transport means in case of transport hindrances.**

All waste will have to respect the acceptance specifications.

- ◆ **The radioactive content of waste packages is declared to Andra by the waste producers.**

**Coherence of accountancy practices.**

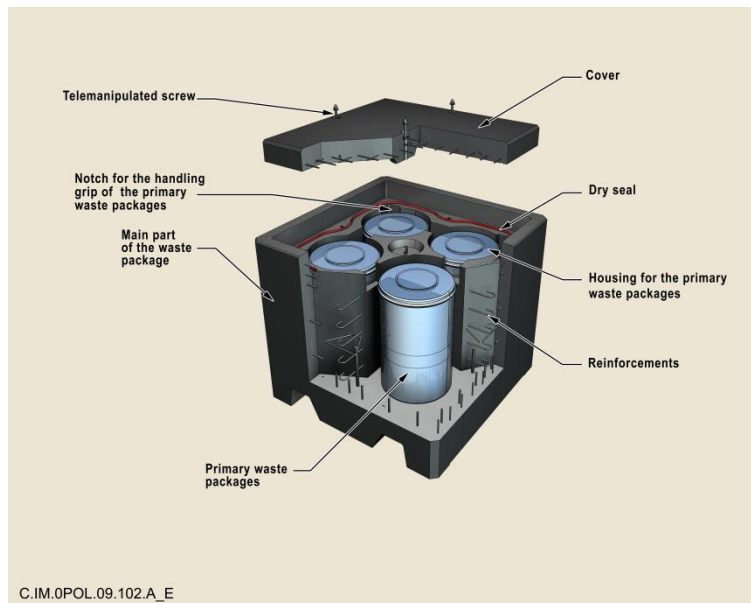
# Preparation for Disposal – Assembling of Disposal packages

Before their transfer underground for disposal, the primary waste packages (packages received from waste producers) are placed in a disposal container:

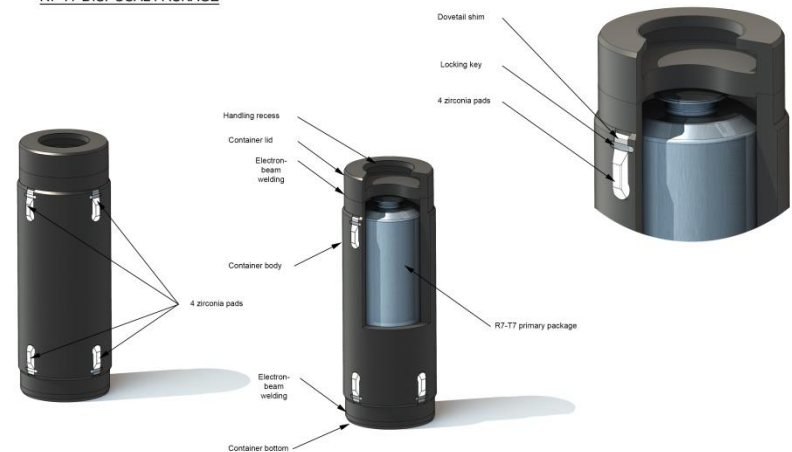
- ◆ Concrete container with screwed lid for ILW-LL
- ◆ Welded steel container for HLW

Cigéo does not extract any nuclear matter from the waste and does not modify the primary waste package received.

**Limitation of theft and diversion risks for objects that weight several tons.**



R7-T7 DISPOSAL PACKAGE

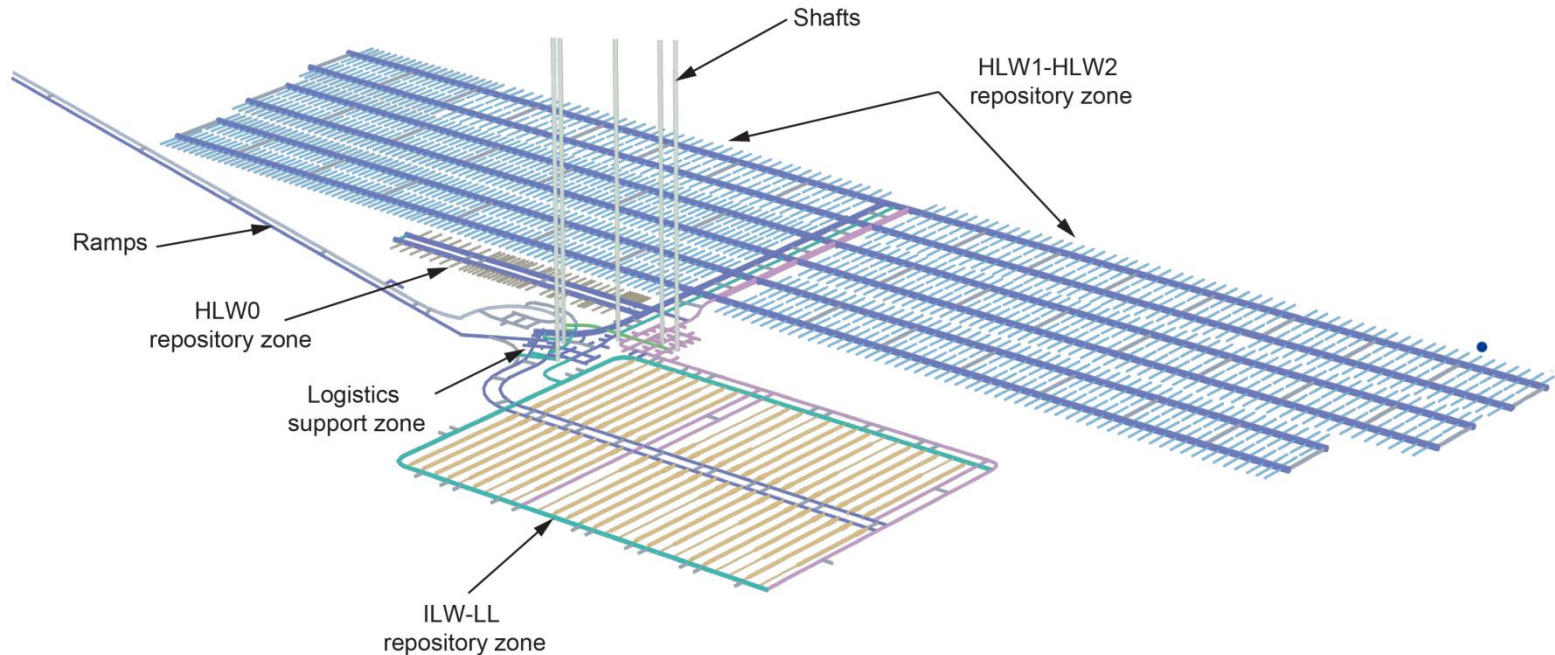


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# The Underground Repository Layout (Independent Disposal Zones for the Different Kind of Waste) – More than Hundred Kilometers of Galleries

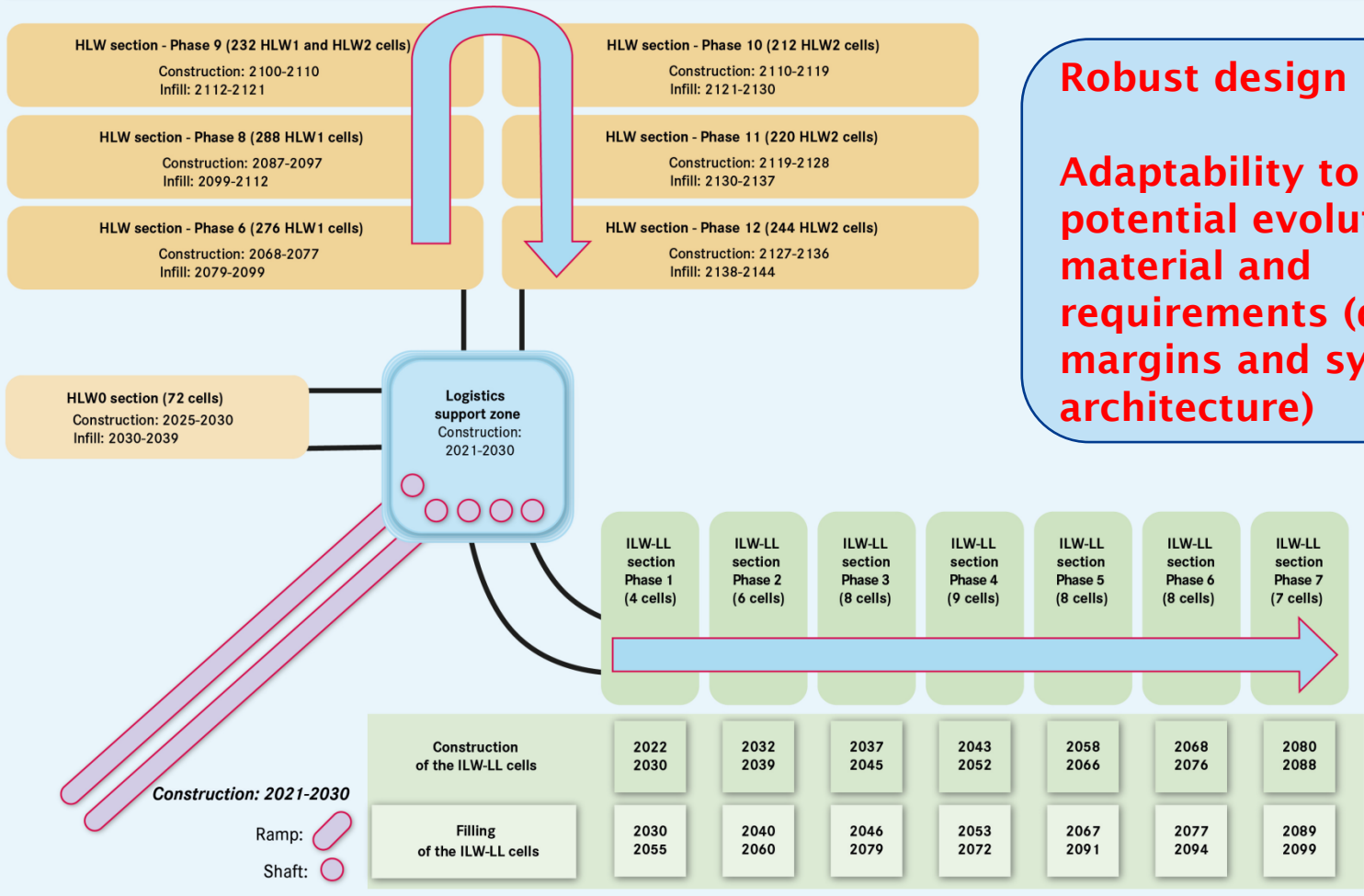
Cigeo underground facilities



**Specific conditions for surveillance and intervention  
Keypoint : prevention of intrusion underground**

# The Specificities of Cigéo – more than 100 years of operations

**SCHEMATIC DIAGRAM OF THE STEPS IN THE CONSTRUCTION AND OPERATION OF THE UNDERGROUND STRUCTURES UNTIL COMPLETION**



**Robust design**

**Adaptability to potential evolution of material and requirements (design margins and system architecture)**

## The specificities of Cigéo – Ongoing Construction Activities

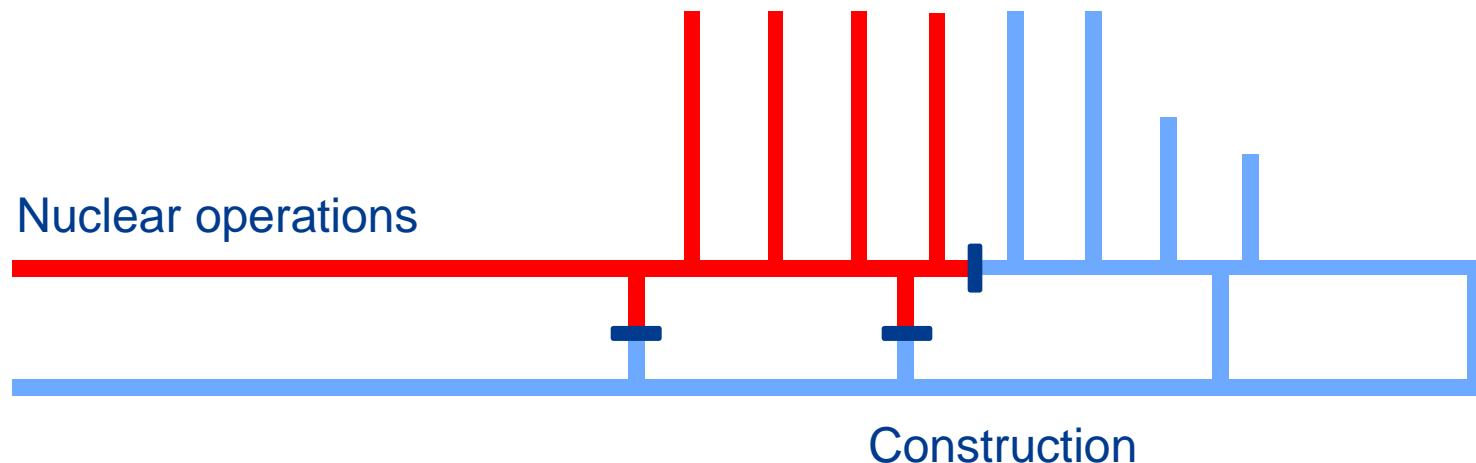
Throughout Cigéo's operating lifetime, the repository zones will be extended during consecutive periods lasting around 10 years each.

The nuclear zones and the construction will be independent :

- ◆ Physical separation ;
- ◆ Separated access for workers and equipments ;
- ◆ Separated utilities.

**Transfer of personnel or equipment from one zone to the other is not permitted (some exceptions have to be considered for emergency situations).**

### Development Principles for the Underground Facility



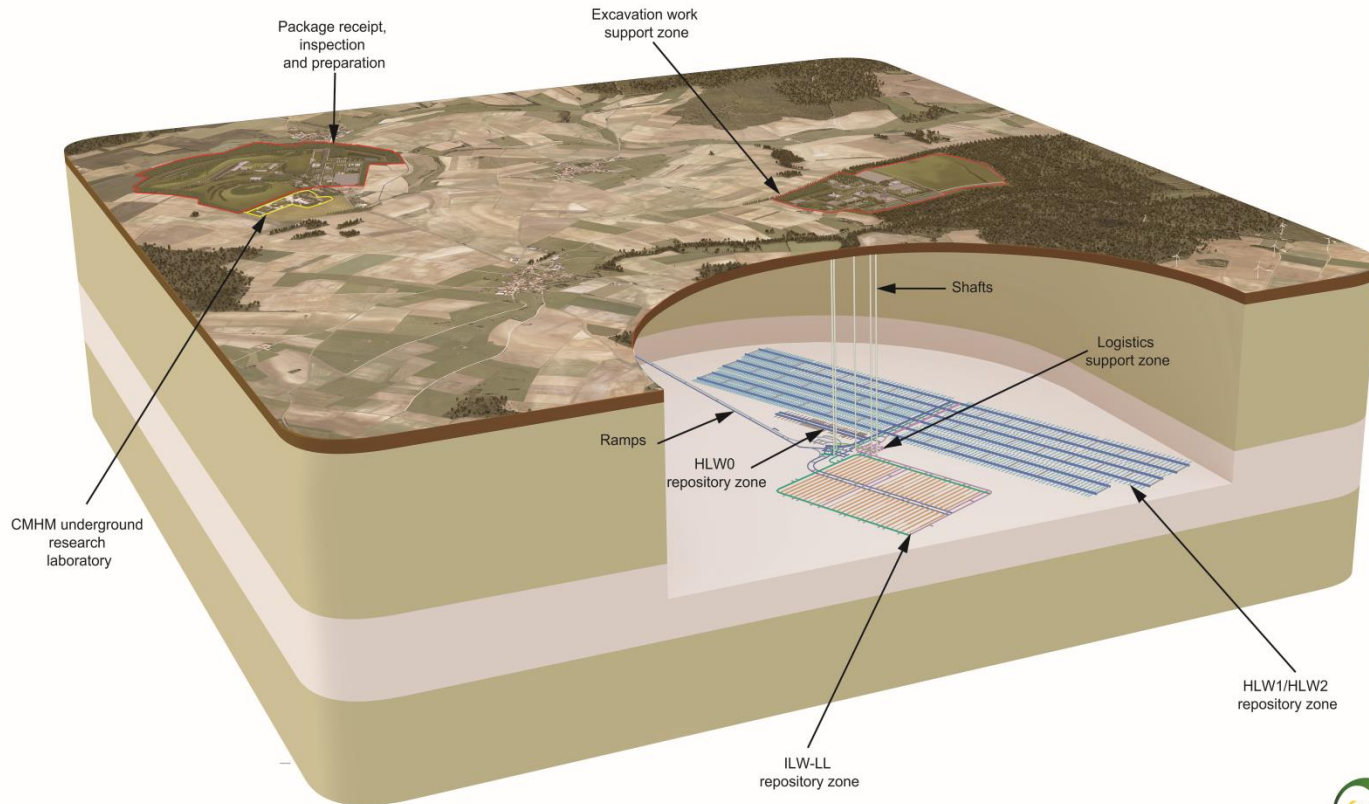


# The Specificities of Cigéo – Appearance of a Radical Form of Opposition Hindering Site Preparation and Characterization



**Attractiveness of the subject “Waste” amongst opponents.  
Securing the construction site is of paramount importance.**

**Preliminary contacts with external intervention forces have been taken. The choice of the most efficient organization for the local facility guards is under evaluation.**



**Underground Disposal is the reference solution for the management a the most dangerous radioactive waste.**

**This kind of facility is under development in several countries.**

**It bears specificities in terms of security :**

- ◆ **Underground activities in a very large facility**
- ◆ **Uncommonly long operation period**
- ◆ **Ongoing nuclear and construction operations**
- ◆ **Growing opposition**

**Regular technical exchange meetings are undertaken at the international level with safety agencies and safeguards authorities (Euratom / IAEA - Astor group).**



### Security of Cigéo the French project :

- ◆ **Security aspects taken into account from the beginning of the design studies**
  - Integration of IAEA security series requirements and technical guidance
- ◆ **National contacts with the security authorities (HFDS)**
  - Integration of National requirements and methodology for threat analysis
  - Production of periodic “security option report”
- ◆ **First contacts with national intervention forces**

Fewer contacts exist at the international level on the security aspects of geological disposals :

- ◆ **Contacts with homologues must be undertaken**
- ◆ **A specific frame for international exchanges and cooperation on security of disposals ?**