Progress of the Cigéo Disposal Project

Jean-Michel Hoorelbeke
Andra - France

INMM 31st Spent Fuel Management Seminar
January 11, 2016
Washington DC
Contents

» Waste Management Strategy in France

» Cigéo Concept

» Cigéo Project: Status and perspectives
Nuclear Fuel Management Policy in France

1. UO\textsubscript{2} 1075 tML
2. MO\textsubscript{2}X 125 tML
3. URe

- Power generation 420 TWh
- NPPs 59 units

Conversion Plant
Enrichment Plant
Reprocessing Plant
Reprocessing Plant (La Hague)
U Mine

- 7000 tU
- 1.000 tU
- 6000 tU

Enriched U
Depleted U

Stored quantities in 2013

*Vitrified HLW (CSD–V): 825 packages/y
*ILW (CSD–C): 715 packages/y

Cigéo Project Geological disposal facility

Waste Storage
CSD–V: 12,441 Pack.*
CSD–C: 12,852 Pack.*
Waste Management Scheme in France

UOX fuel reprocessing, Pu+U recycling (MOX, URe)

- Heat decrease storage of final HLW
- Interim storage of final ILW
- Interim storage of reusable matter (MOX SF; depl. U)

- Early disposal of older HLW
- Disposal after 60-90 y. for currently produced HLW
- Disposal of ILW with a view to making the best use of storage capacities
- Reuse in GenIV reactors
- Heat decrease storage + disposal?

As necessary, Cigéo can be adapted to direct disposal of spent fuel.

Prospective studies on GenIV waste disposal

© Andra
Cigéo is designed for the waste generated by existing nuclear facilities, under operation (50 years for PWR) or licensed

**SF Reprocessing Waste**
- Vitrified HLW
- Clads, ends (ILW)

**Other ILW, generated by the operation of nuclear facilities**
- Solidified effluents
- Maintenance waste
- Activated waste (NPPs and ITER)

<table>
<thead>
<tr>
<th></th>
<th>Total volume to be disposed of (m³)</th>
<th>Volume already produced in 2010 (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitrified HLW</td>
<td>10 000</td>
<td>2 700</td>
</tr>
<tr>
<td>ILW</td>
<td>73 000</td>
<td>40 000</td>
</tr>
</tbody>
</table>
State owned, independent from the waste producers

Responsible for the long-term management of all radioactive waste produced in France

650 employees

Funded mainly by waste producers

- on a commercial basis for industrial activities
- through a tax for RD&D on geological disposal

Andra's activities are conducted under the aegis of the 2006 Waste Act
Waste Management Strategy in France

Cigéo concept

Cigéo Project: Status and Perspectives
Siting: a Converging Approach

1– Siting started in 1992 with a National call for volunteering; URL licensed 1998

2– Transposition zone of URL results (proposed 2005)

3– Area defined for location of U/G facilities after local consultation (2009) and detailed geological survey from the surface

Detailed survey in 2010

Additional above-ground geological survey 2007-2008

4– Location of surface facilities
Cigéo Project Layout

Waste Reception Area

Construction support facility

Ventilation and service shafts

U/G facility at the median of the host clay layer => depth: 500 m

Waste transfer ramp and service ramp

HLW disposal (2075–2140)

ILW disposal (2030–2085)

HLW disposal (2030–2040)

View of the U/G facility after ~100 years in operation
Cigéo Safety Concept

Post closure safety is mainly based on the host clay layer:

- Provisions for siting, geological survey and URL;
- Repository designed to limit induced disturbances;
- High confidence in long term safety demonstration.

- Low permeability;
- Depth and thickness;
- Favourable geochemistry;
- Geodynamic stability.

View of the U/G facility after ~100 years in operation
HLW Disposal Packages

HLW will be placed in 65mm steel overpacks to prevent glass leaching during the thermal phase:

- Ceramic skids for easy handling
- Gripping Interface
- Vitrified HLW Stainless Canister
- Steel containers have also been studied and prototyped for Spent Fuel
Heat conduction in clay
- max. temp in clay rock: 90 °C
- Limitation of large scale THM effects

Steel liner

Cell length (100 m) to be optimized with regard to technological limits and cost
ILW disposal cells are horizontal tunnels:

» Length: ≈400 m
» Excavated diameter: 9 m
» Thick concrete lining to limit long term deformations;
» Ventilation of ILW repository cells as long as they are not closed.
Backfilling and Sealing

- Access shafts and ramps

- U/G drifts
Reversibility = enhancement of the possibilities given to next generations to reconsider the decisions taken previously, of the range of choices open to future generations.

In practice, the implementation of reversibility relies on a set of governance (G) and technical (T) tools:

- (G) Continuous improvement of knowledge (R&D; monitoring);
- (T) Incremental development, progressivity of construction;
- (T) Flexibility of operation and relating time-schedules;
- (T) Adaptability of installations;
- (T) Retrievability of waste packages;
- (G) Transparency and transmission of knowledge;
- (G) Involvement of society;
- (G) Control by the State and reviewers under the supervision of the Parliament.
Reversibility: Incremental Development, Progressivity
Reversibility

« Toolbox »

- (G) Continuous improvement of knowledge (R&D; monitoring);
- (T) Incremental development, progressivity of construction
- (T) Flexibility of operation and relating time-schedules;
  ➢ Progressive and adaptable closure time-schedule
- (T) Adaptability of installations;
  ➢ Capability to accommodate non reprocessed spent fuel as decided in the future)
- (T) Retrievability of waste packages;
- (G) Transparency and transmission of knowledge;
- (G) Involvement of society;
- (G) Control by the State and reviewers under the supervision of the Parliament.
Reversibility: Adaptability of Installations
Reversibility

« Toolbox »

» (G) Continuous improvement of knowledge (R&D; monitoring);
» (T) Incremental development, progressivity of construction
» (T) Flexibility of operation and relating time-schedules;
  ➢ Progressive and adaptable closure time-schedule
» (T) Adaptability of installations;
  ➢ Capability to accommodate non reprocessed spent fuel as decided in the future)
» (T) Retrievability of waste packages;
» (G) Transparency and transmission of knowledge;
» (G) Involvement of society;
» (G) Control by the State and reviewers under the supervision of the Parliament.
Reversibility: Retrievability

Equipments, waste packages, disposal cells are designed in order to allow package retrieval

Opening of the cell

Retrieving the waste package

Transfer back to surface

Waste package removal tests in a deformed cell
Reversibility

« Toolbox »

- (G) Continuous improvement of knowledge (R&D; monitoring);
- (T) Incremental development, progressivity of construction
- (T) Flexibility of operation and relating time-schedules;
  - Flexible stepwise closure process
- (T) Adaptability of installations;
  - Capability to accommodate non reprocessed spent fuel as decided in the future)
- (T) Retrievability of waste packages;
- (G) Transparency and transmission of knowledge;
- (G) Involvement of society;
  - Periodic appointments (10 years) with the stakeholders, to prepare decisions
Reversibility

« Toolbox »

- (G) Continuous improvement of knowledge (R&D; monitoring);
- (T) Incremental development, progressivity of construction
- (T) Flexibility of operation and relating time-schedules;
  - Flexible stepwise closure process
- (T) Adaptability of installations;
  - Capability to accommodate non reprocessed spent fuel as decided in the future)
- (T) Retrievability of waste packages;
- (G) Transparency and transmission of knowledge;
- (G) Involvement of society;
- (G) Control by the State and reviewers under the supervision of the Parliament.
Contents

- Waste Management Strategy in France
- Cigéo Concept
- Cigéo Project: Status and perspectives
Recent Development of the Cigéo Project

❖ Public debate in 2013

❖ Basic design: 2012 to 2015
  • Design and dimensioning of facilities,
  • Operational safety

❖ Strong development of the URL
Outcomes of the 2013 Public Debate

Four changes to the project resulting from the public debate:

- An **industrial pilot phase** will be integrated into the facility startup phase;
- A **master plan for Cigéo operation and closure** will be drawn up and regularly revised;
- Clarification to the **project calendar**;
- More **involvement of Society**.

New proposal regarding reversibility.

A direct connection between Cigéo site and the existing rail network (14km).
Recent Development of the Cigéo Project

- Public debate in 2013
- Basic design: 2012 to 2015
  - Design and dimensioning of facilities,
  - Operational safety

- Strong development of the URL
Progress in Technology Demonstration

- U/G construction techniques
- Sealing
Updated Provisional Time-schedule

- Public Debate: 2013
- Proposed Master Plan: 2016
- Safety Options: 2016
- Retrievability: 2016
- Technical Options: 2016
- Application: 2018
- Licence: 2021
- First Waste Package Emplacement: 2025
- Start of Industrial Pilot Phase: 2030

Detailed design

Reviews

Amenities

Construction
Industrial pilot phase:

- Inactive tests from 2025 to 2029
- Emplacement of first HLW and ILW packages from 2030
- Gradual increase in activity from 2030 to 2035
Local Territory Development

Thank you...