THE GRADED APPROACH IN THE MANAGEMENT OF DECOMMISSIONING WASTE IN FRANCE

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Introduction

Very Low-Level Waste
- Sizing the problem
- Improving disposal route
- New disposal route
- Alternative solutions

Low Level Long-Lived Waste
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- Specific disposal constraints
- Solutions?
Current situation in France:
- Disposal of VLLW and short-lived LLW in Andra’s surface facilities.
- Cigéo project for long-lived ILW and HLW.

Building a global approach of the management of all radwastes (and materials if reclassified into waste):
- Exhaustive with respect to waste inventory,
- Coherent with regard to safety and best environmental practice,
- Proportioned to waste harmfulness.
Harmfulness indicators are being elaborated in France to support Waste management strategy

Taking into account:

- Activity level
- Radioactive decay
- Radiotoxicity
- RN mobility
- Non radioactive harmfulness (on Man and the Environment)

LL-LLW: Distribution of non radiological harmfulness with regard to conventional waste regulation (Additional types of waste considered since 2016 are not taken into account)
Very Low-Level waste
VLLW
A significant part of decommissioning waste

Inventory of the decommissioning wastes to be disposed of in 2040
A saturation of regulatory capacity by 2025 ... which could be postponed to 2030

Volumes of VLLW delivered (cumulative since 2003, + forecasts)

... provided an extension of the currently authorized capacity to ≈ 900 000 m³, within the current available area
The CIRES VLLW facility

- Commissioned August 14th 2003
- Area: Total: 43 ha; disposal area: 28.5 ha
- Licensed disposal capacity: 650,000 m³
- >50% of the regulatory disposal capacity used
- Operating life: initially estimated at approximately 30 years
- Processing units: compaction units, solidification unit, package verification facility
Changes to disposal cell design

The technical capacity of the facility could be higher by about 40% than its presently licensed capacity.
The initial use of the disposal area

Initially 650,000 m$^3$

Disposal area

Clay storage area
Clay storage area

Disposal area

Presently 650,000 m$^3$

+ ~ 250,000 m$^3$
Scenario in the continuation of the current scheme

- A new VLLW disposal facility to be commissioned around 2030
- A capacity of about 1 million m$^3$
- Flow averaging 35,000 m$^3$/an
### Optimization of the volumes: The technical options studied

<table>
<thead>
<tr>
<th>Option</th>
<th>Potential for annual flows reductions to CIRES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VALORISATION</strong></td>
<td></td>
</tr>
<tr>
<td>Scrap metal</td>
<td>10 000 m$^3$/y (on average)</td>
</tr>
<tr>
<td>Rubble</td>
<td>1 800 m$^3$/y</td>
</tr>
<tr>
<td><strong>VOLUME REDUCTIONS</strong></td>
<td></td>
</tr>
<tr>
<td>Metals (fusion for densification)</td>
<td>12 000 m$^3$/y (on average)</td>
</tr>
<tr>
<td>Incinération</td>
<td>2000 m$^3$/y</td>
</tr>
<tr>
<td>Compaction</td>
<td>&lt; 2000 m$^3$/y</td>
</tr>
<tr>
<td><strong>REORIENTATION</strong></td>
<td></td>
</tr>
<tr>
<td><strong>ALTERNATIVE DISPOSAL</strong> (simplified)</td>
<td></td>
</tr>
<tr>
<td>For VVLW</td>
<td>Up to 10 000 m$^3$/y</td>
</tr>
</tbody>
</table>

**Non-cumulative scenarios**

Options to be assessed as to their technical, economic, environmental efficiency and to the social acceptability
Main conclusions

A technical capacity of 900 000 m³ for CIRES

- With a technical capacity of 900 000 m³, the CIRES can ensure the continuity of the acceptance of VLL wastes by requesting an extension of the regulatory capacity within the site area.
- Needs for additional disposal capacity by 2030 will range between 600,000 and 1,200,000 m³ according to the different scenarios studied.

Main issues

- Successfully recycle metallic waste, which can be dismantled without contamination above natural level, after melting.
- Quantify wastes with extremely low activity level, for which disposal at CIRES constitutes an "oversized" solution.

➔ A dialogue on the relevance of options with waste producers.
Low level Long-Lived Waste
Waste activities evolution

Average specific activity (Bq/g) vs Time (y)

- LL-ILW (Cigéo): ~ 75 000 m³
- LL-LLW > 250 000 m³
- SL-LLW (CSA): 1 000 000 m³
Towards a graded approach in waste management

The French RW inventory identifies a range of waste with hazards in between the waste that can be accommodated in existing surface disposal facilities and those intended for Cigéo:

**Short lived LLW – disposed of on the surface (CSA)**

- Limited inventory in long lived RN:
  - $^{41}$Ca : 0.12 TBq
  - $^{14}$C : 815 TBq

**« Low level long-lived wastes »**

- Moderate content in long lived RN:
  - $^{36}$Cl : 2,2 TBq
  - $^{41}$Ca : 2 TBq
  - $^{14}$C : 927 TBq

- Moderate specific activity (Bq/g):
  - $^{36}$Cl (Graphite) : de 29 à 260
  - $^{99}$Tc (Bitumes) : 800
  - $^{129}$I : 4
  - $^{79}$Se (Bitumes) : 1,67

- ILW to be disposed of in Cigéo

  - Specific activity (cladding and endpieces) (Bq/g):
    - $^{36}$Cl : 530
    - $^{99}$Tc : 6 330
    - $^{129}$I : 7,5
    - $^{79}$Se : 77

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Towards a graded approach in LLW-LL management

• The French Act (2006) provides for a **shallow depth** disposal concept for **low level and long-lived waste**;

• There is no threshold to define a shallow depth in France.

  ◆ The Safety Guide issued by the French regulator (ASN) for **deep** geological disposal defines a 200 m depth threshold for such a facility with regard to isolation over very long periods.

**IAEA definitions**:

• **Near-surface** addresses depths up to a few tens of meters: 0-30m typically;

• The concept of “intermediate depth disposal” associated to ILW is no more considered as appropriate;

• The concept of “**geological disposal**” might be extended in the future to any underground disposal facility at a depth higher than “a few tens meters”.

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Towards a graded approach in waste management

- Technical and economical optimization of waste disposal routes
- Moderate specific activity not requiring deep disposal
- Content in long lived RN not compatible with CSA
- Disposal at a shallower depth

Safety
Cost
Technical solutions
Safety factors for defining an appropriate shallow depth and relating waste acceptance criteria

- **Time frame to be considered for long term safety functions**
  - Long term safety functions are available as long as the site specific geodynamic evolution does not significantly modify the configuration of the disposal system (via surface alteration processes, erosion, glaciation).

- **Isolation performance**
  - The isolation performance is directly connected to depth (IHI scenarios...)
  - Its suitability depends on the toxicity of RN and other substances in the waste and their concentration.

- **Containment performance**
  - The containment performance depends on:
    - site specific properties: permeability, hydraulic gradient, redox, retention, thickness of host formation, hydraulic conditions of outlets;
    - additional engineered barriers.
  - The needs for containment is a function of the types of radionuclides in the waste (their mobility in particular) and their amount.

- **Residual impact after loss of safety functions**
  - is a function of the decrease in the radiological content of the waste with time (half lives) and of concentrations.
2 construction methods at shallow depth

Solution 1
Open air

Solution 2
Underground

Alvéole de Stokage

Container de commande
Système de marinage

Roue de coupe
Tuyaux de lançage
Tunnelier
Bâti de poussée

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Range of shallow depths in clay

Open pit

U/G Digging
Defining long term management routes for LL-LLW is complex

- The French Regulator (ASN) considers that the Aube site will not be capable to accommodate all LL-LLW.

- The PNGMDR provides for new site screening in addition to the Aube site under survey.
  - A wider range of disposal concepts needs to be studied.

- Need to clarify the modalities of a graded safety approach in France:
  - What balance between isolation and containment?
  - What role for IHI scenarios?
  
  ➢ ASN safety guide is being updated
Thank you!

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