WASTE MANAGEMENT STRATEGY

“French Experience in Legacy Waste Management”

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1. Nuclear waste management at the CEA  
2. Legacy waste : The CEA D&D Perimeter  
3. Legacy waste : Technologies and processes  
4. Conclusion
1. Nuclear waste management at the CEA

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Waste classification principle

- 5 waste categories
- In France waste is classified according to two main criteria:
  - Its radioactivity level
  - Its lifetime: “short-lived” waste (half-life ≤ 31 years) and “long-lived” waste (half-life > 31 years)

<table>
<thead>
<tr>
<th>Type of Waste</th>
<th>Short lived nuclides &lt; 30 year</th>
<th>Long lived nuclides &gt; 30 year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface disposal (operational) Very Low Level Waste</td>
<td></td>
<td></td>
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<tr>
<td>Surface disposal (operational) Low and Intermediate Waste</td>
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<tr>
<td>Expected Geological disposal High Level Waste</td>
<td></td>
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<tr>
<td>Near surface disposal (expected)</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>LOW ACTIVITY</th>
<th>HIGH ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>VLLW</td>
<td>Bq/g &lt; à 100</td>
</tr>
<tr>
<td>LILW-SL</td>
<td>100 to 1 000 000</td>
</tr>
<tr>
<td>LLW-LL</td>
<td>10 to 100 000</td>
</tr>
<tr>
<td>ILW-LL</td>
<td>1 000 000</td>
</tr>
<tr>
<td>HLW</td>
<td>1 000 000 000</td>
</tr>
</tbody>
</table>

- Reprocessing waste
DISPOSAL FACILITIES OPERATED AND STUDIED BY ANDRA

**VL-LW**
« Cires »
Short and long-lived

**LLW**
“Centre de l’Aube »
Short-lived

**LLW**
Under study

**ILW & HLW**
Under study
CIGEO project
Long-lived

**Short and long-lived**

**CEA : ~ 10 000 m³/y**

**CEA : ~ 4 000 m³/y**

- Graphite (UNGG Reactors)
- Bitumen drums,
- Radium-bearing waste
General principle for waste management at the CEA

- **Characterization of**
  - Legacy waste
  - D/D waste
  - R&D waste

- **Liquid and solid waste treatment**

- **Dedicated R&D program in support of waste management**
  - To develop efficient waste treatment
  - To define new matrices for specific waste
  - To optimize the categorization of the waste

- **Waste management**
  - If storage site exists
    - National storage
  - If not
    - Intermediate storage on CEA site
CEA DEN FACILITIES FOR SOLID WASTE TREATMENT

SACLAY
- INB 72
- Facility for various types of waste from R&D and D&D program

MARCOULE
- Short-lived waste
- Sludge cementation unit
- Mg cementation unit

CADARACHE
- Long-lived waste

INB 37
- Intermediate storage

Surface disposal
- Specific Conditioning Unit for dedicated waste
Specific case of Long-Lived Waste (LL and IL)

Low-level, long-lived waste
Intermediate-level, long-lived waste

Non defined matrix → Deactivation → defined matrix (cement matrix, bitumen matrix)

DIADEM → Geological disposal

CEDRA (Cemented waste packages)
EIP (Bitumen drums)

Intermediate storage → Surface disposal Short-lived waste → Geological disposal
**CEA INTERMEDIATE STORAGE FACILITIES**

- **SACLAY**
  - Short-lived and long-lived waste
  - INB 72

- **CADARACHE**
  - Cemented waste packages

- **FONTENAY**
  - Long-lived waste

- **MARCOULE**
  - EIP (Bituminized drums)

- **CEA INTERMEDIATE STORAGE FACILITIES**
  - Long-lived waste

- **CEDRA**
  - (Cemented waste packages)

- **HLW**
  - AVM (Glass canisters)

- **DIADEM**
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Legacy waste retrieval, characterization & repackaging

- HA4: Organic liquid tank
- INB 72
- INB 35
- INB 166
- Fontenay-aux-Roses
- Saclay
- Grenoble
- Cadarache
- Marcoule
- RCD 56
- CIRCE – Radioactive liquid tank
- Solid waste
- PEGASE – Radioactive liquid tank
- PEGASE Pool
- Liquid waste (including organics)
- Legacy solid waste
- Spent fuel
- Bituminized waste drums
- Mg waste - UP1
- UP1: retrieval and conditioning of legacy waste
- PHENIX
- Vitrification facility
- Legacy waste (glass containers)
- Sludge
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R&D actions

Liquid and solid waste treatment and conditioning
- R&D on specific waste and effluent issued from D&D and legacy waste from laboratory scale through to industrialization phases
  - To develop efficient waste treatment (plasma torch incineration for organic halogenous liquids, decontamination foams,…)
  - To define new matrices for specific waste (geopolymer for Mg)

Vast range of waste
- Mercurials, sodics, Mg from decladding, powders, sludge, ash, filters, resins

Waste characterization
- R&D to optimize quantities and waste categorization
  - Passive and active neutronic
  - γ and α imaging, γ spectrometry
Example: Cement matrix

At stake
- To define new matrices suitable for a large variety of waste (Legacy waste, current and future waste of exploitation)
- To improve the performance of the matrix (Rate of incorporation, …)

Development
- Packaging of reactive metals: Magnesium, aluminium, …
  - Embedding with geopolymer
  - Process tested and approved in inactive at scale one for Mg
- Other types of waste: Sludge, resins, powder
  - Development of cementing formulations underway
Example: solid waste treatment

- At stake
  - To reduce uptake doses
  - To optimize waste categorization by increasing decontamination efficiency
  - To reduce the amount of secondary waste produced

- **FOAMS**
  - Foam with $^{137}\text{Cs}$
  - Active agent adsorbed on surface by bubbles
  - Decontamination foams
  - Decontaminated soil
  - Floating foams

- **GELS**
  - Drying
  - Final solid waste
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Specificity of the CEA in waste management due to a vast range of waste

Special R&D role
- To develop efficient treatments for complex radioactive waste
- To develop new matrices in particular for long-lived waste
- To develop treatment and matrices for a vast range of waste
- To characterize waste
Thank you for your attention