Evolution of the waste forms in the future: an overview of the French management approach

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Outline

- HL and ILL waste inventory
- Current approach for the HL and ILL waste expected in Cigéo: an iterative approach
- Specific issues for different waste
  - Metallic waste
  - Organic waste
- The approach for future waste

HL and ILL waste inventory

⇒ defined from « The industrial program of waste management »

↳ Iterative work between Andra and the waste producers

- Existing and future HL and ILL waste generated by the current nuclear facilities (nuclear power reactors, reprocessing facilities, R&D facilities).

- HL and ILL waste that will be generated by future facilities whose licencing decree has already been accepted (Gen III EPR Flamanville, experimental reactor Jules Horowitz, ITER reactor).

		Number of primary waste packages
HL waste	HL nuclear glasses	55 771
	Other HL waste	262
	Total	~56 000
ILL waste	Metallic structures of spent fuel	61 211
	Operational/Dismantling waste	114 770
	Total	~176 000

Current approach for the HL and ILL waste expected in Cigéo: an iterative approach

Key principles

A good knowledge of long-term behavior of HL and ILL waste in disposal conditions requires a good knowledge of waste.

Since 1997, Andra defined specifications for knowledge files established by the producers for the existing waste or future waste that may be disposed in a future geological repository.

- General informations
  - Type of waste
  - Production site
  - Quantities of waste (already produced, assessment of future production)
- Description of primary waste packages
  - Geometry / mass data
  - Closing and handling
  - Nature of materials (composition)

Current approach for the HL and ILL waste expected in Cigéo: an iterative approach

- Description of waste
  - Conditioning process
  - Nature of materials (composition)

    ↳ chemical composition : complexing species (NO_3^-, SO_4^{2-}, EDTA, TBP …), toxic species (Hg, Pb, Be, As …)
  - Radiologic content
  - Thermal power
  - Gas production
  - Dose rate
  - Storage conditions
  - …

= iterative approach between Andra and producers

The producers are responsible for the data given to Andra but periodic control on production sites are organized :

- ✓ Respect of production specifications
- ✓ Identification of non-conform waste packages
- ✓ Technical survey …

Current approach for the HL and ILL waste expected in Cigéo: an iterative approach

Other advantages of iterative approach

- to take into account any evolution of ongoing production through discussions with producers
  - increase of radionuclides content (R7/T7 specifications of production)
  - modification of materials (cladding materials: Zircaloy / Zirlo / M5)

- to take into account trends of EDF's fuel management and consequences on fuel cycle
  - « Cycle impact » : consistency between fuel management and waste management
    - ↳ Initiative started by ASN involving Areva NC and Andra

- to take into account the questions linked to the repository for the future waste
  - for Areva : New waste = new specification of production ⇨ requires the approval of safety authorities
    - ↳ Andra is involved in the process in order to assess the compatibility of future waste with the repository design and safety criteria

Current approach for the HL and ILL waste expected in Cigéo: an iterative approach

Other advantages of iterative approach

- to organize specific R&D
  - Andra identifies specific R&D needs in order to:
    - precise the characteristics of waste
    - improve the conditionning process
    - determine the evolution of HL and ILL waste in repository conditions
  - Technical committe Andra/producers

Example 1: Metallic waste

Some issues associated to metallic waste :

- Radionuclide release
- Gas production induced by corrosion (H_2)
- Exothermic reactions for some metals, risk of explosion

Necessary knowledge about :

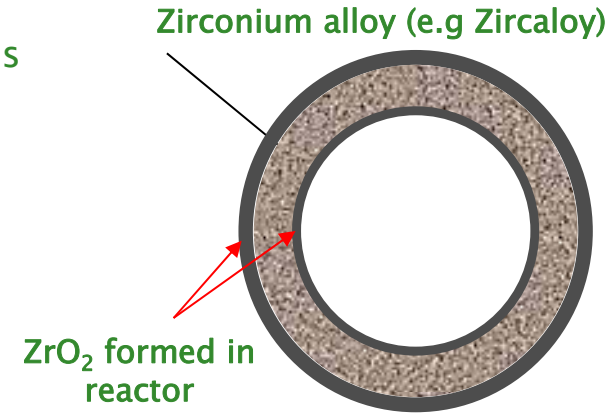
- Nature of metals / alloys
- Corrosion rate in repository conditions
  - Gas production
  - Radionuclide release
- Geometric forms of waste (powders, metallic pieces …)
- Radionuclide distribution in metallic waste

Example 1: Metallic waste

Distribution of radionuclides in irradiated cladding of spent fuel :

- Fission products: formed through fission during irradiation
  - → embedded by fission recoil in the internal zirconia layer (≈ 95 % FP)
  - → partially located at the surface during reprocessing process

- Activation products : formed under neutron flux during irradiation
  - → Uniformly distributed throughout the metal and metal oxide



Consequences for the radionuclide release

- For RN located at the surface and in zirconia layer : instant release fraction
  - → Need to know zirconia layer thickness

- For RN located in zircaloy : release according to the corrosion rate
  - → Need to know corrosion rate and geometry of metallic pieces

Example 2 : organic waste

Some issues associated to organic waste

- Gas production by radiolysis (H_2, HCl …)
- Production of complexing or aggressive species as radiolysis by-products
  - May form chemical complexes with radionuclides : impact on radionuclide migration
  - May contribute to the degradation of concrete (waste packages, disposal cells).
- Microbial activity
  - Organic waste may be a source of nutrients for microorganisms

Necessary knowledge about :

- Nature and quantity of organic waste (different polymers)
- R&D topic: development of another conditioning process

For future waste : a similar approach

- State of knowledge: What are the specificities of future waste ?
  - New material ?
  - Evolution of composition or radiologic content ?
  - New conditioning process ?

- First analysis based on current knowledge and the Cigeo design (current reference)
  - Compatibility with the Cigeo repository design ?
  - Specific issues in repository conditions (operating / post-closure safety) ?

The earlier Andra and producers can exchange about characteristics and management of future waste, the better it is.

Conclusions

For future waste : a similar approach

- Short-term evolution (future waste of current facilities)
  - Current approach = Cooperation between Andra and the producers (EDF, CEA, Areva) : Expected evolution are discussed with Andra in order to take them into account in the Cigeo studies, R&D program …
- Long-term evolution (future waste of future facilities)
  - Preliminary discussion as soon as possible to get first informations about the nature and potential specificities of waste
    - Astrid reactor
    - GEN IV reactors

Conclusions

Other cases

- Nuclear spent fuel
  - not considered as waste but ongoing R&D studies in accordance with the recommendations of the National Plan Management for Radioactive Materials and Waste.

- Other waste (radwaste inventory)
  - Possibility to include in Cigeo = compatibility study