CEA strategy for civil spent fuels

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Spent Fuels to be Managed

CEA = a long history of reactors, hot labs and PIE
- Fuels from heavy water reactors, UNGG.
- Fuels from MTR (Osiris, Siloé,…)
- Fuels from critical mock-up,
- Fuels from safety reactors (Phébus,…)
- Fuels from FBR (Rapsodie, Phénix)
- Fuels from PWR after PIE…

=> a large variety of shapes to deal with…
General Strategy

Spent fuels will be reprocessed, there are not considered as wastes.
In some cases, reprocessing can be delayed.
Limitations:
- Inadequate physical or chemical forms,
- Difficulty for handling special assemblies,
- Low quantities.

If improper for reprocessing = wait for final disposal.

CIGEO project.
2025 and beyond

=> Need for containerization & interim storages.
Reprocessing – Past & Present

1993-1997: reprocessing in UP1 plant - Marcoule
- Heavy water, UNGG fuels, Rapsodie upper blanket.
- UO₂ Osiris plate-type: pre-cutting before dissolution


2001-2011: send to reprocessing - La Hague
- UAl-type MTR: Scarabée, Siloe, Siloette, Orphée, Ulysse
- U₃Si₂ plate-type Osiris MTR.

Osiris
Reprocessing – Future

New agreements to be settled with AREVA:

- Phénix fuel pins
- Phébus assemblies (PWR-type rods) \( \downarrow \) Shutdown reactors
- UAl-type: Orphée
- \( \text{U}_3\text{Si}_2 \)-type Osiris \( \downarrow \) Reactors in operation

*Shipment of Osiris spent assemblies to La Hague with a TN-MTR cask*
Containerization facilities: STAR

STAR in Cadarache:

1995-2004: stabilization of UNGG cartridges (pyrophoricity) in a cell under argon. Canisters are under inert atmosphere.

Now: reconditioning of several types of spent fuels (FBR, PWR)

A refurbishment programme is in progress.

2010-2013: reconditioning of spent fuels stored in PEGASE

Later: reconditioning of epoxy-embedded fuel samples
Containerization facilities: ISAI

ISAI in Marcoule:
Very large hot cell. Crane = 1000 kN capacity.
Main programme: containers for Phénix FBR fuel pins.
Phénix assemblies are dismantled in Phénix hot cell.
Then pins are containerized in ISAI & send to interim storage.
Shipment to La Hague will be performed with a TN 17.2

A refurbishment programme is in progress.
Later: will also be used for Highly Active solid waste containers
Interim storages: PEGASE

PEGASE in Cadarache:

An old reactor pool converted to a pool-type storage facility in 1980, first for storing 50 t of heavy water spent fuels (EL4). Then used for storing many types of fuels.

To be shutdown: do not comply with new seismic rules.

All spent fuel canisters should transferred elsewhere.

Some canisters containing epoxy-embedded samples.
Interim storages: CASCAD

CASCAD in Cadarache:

A recent well-type facility, started 1996.
Interim storage up to 50 years.
Recent safety reassessment.
Natural ventilation system.
**Interim storages: flux**

PEGASE (to be shut down)

CASCAD

Reconditioning in STAR

RES canal: pool-type => until 2024
only used for UO₂ Osiris plates & epoxy-embedded fuels

Underground storage or Reprocessing
Hot cell Processes

Welding:
A classical equipment, for sealing the canisters (STAR, ISAI).

But very stringent quality controls (long storage)

Checking the absence of water (criticality):
Development of X-rays under water
(qualification in progress)
Hot cell Processes

Drying the canisters:
Method: vacuum pumping, then inert gas (N₂) filling

Drying equipment inside C3 hot cell in STAR
Hot cell Processes

Removing epoxy embedding (hydrogen release hazard):
- Mechanical removal.
- Then, pyrolitic treatment above 550°C under inert atmosphere
  => Not operational, still under development…

- Can be combined with stabilization furnace (for UNGG fuels)
Conclusions

A long nuclear history = a large quantity of spent fuels to deal with.

Main strategy = reprocessing in La Hague
But not always technically or economically reasonable.

Waiting for underground storage (open 2025)

⇒ Interim storages facilities + reconditioning facilities
⇒ A few technical developments inside hot cells
⇒ Lots of transportations.

⇒ Careful optimization to limit the costs
Thanks for your attention.

Any questions?