Identification of Disposal Facilities for Disused Sealed Radioactive Sources

AIEA international workshop on « Sustainable Management of Disused Sealed Radioactive Sources »

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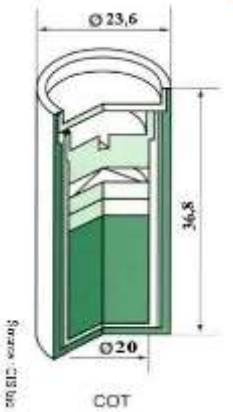
OUTLINE

1. Regulation framework
2. Disposal facilities
3. Main disposal parameters
4. DSRS management scheme

1. Regulation framework



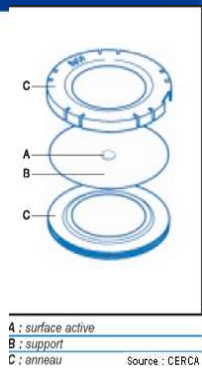
The French National Radioactive Waste Management Agency (Andra) is a public body with industrial and commercial activities set up by the Act of 30 December 1991. It was assigned further responsibilities under the planning Act of 28 June 2006 on the sustainable management of radioactive materials and waste. Andra is independent of radioactive waste producers and supervised by the French Ministries of Energy, the Environment and Research.

Andra is responsible for the sustainable management of radioactive waste in France. It provides the Government with expertise and know-how to find, implement, and guarantee safe solutions aimed at ensuring short and long term protection of human health and the environment against the impact of this waste.

The French 2006 Act on sustainable radioactive waste management provides for the DSRS disposal in existing or projected repositories for radioactive waste.

As planned by this Act, Andra proposed to the Government by the end of 2008 an overall DSRS management scheme. This scheme was submitted in 2009 to the French Safety Authority for instruction prior to its integration into the National plan on management of radioactive materials and waste (PNGMDR).

2. Disposal facilities (1/6)



- ✓ The National plan on management of radioactive materials and waste (PNGMDR) provides for four types of repositories :
  - ❖ CSTFA : Surface facilities under operation, dealing with very low level waste.
  - ❖ CSFMA : Surface facilities under operation, dealing with short lived- low and intermediate-level waste.
  - ❖ A repository in a deep clay layer is currently designed for HLW and long lived- ILW. Investigations are carried out in the Meuse/Haute Marne URL. The repository operation is scheduled in 2025.
  - ❖ A shallow depth repository is envisaged for long lived- low level waste such as radium bearing waste.

2. Disposal facilities (2/6)

✓ CSTFA :

- VLLW disposal facility : 50% of "industrial waste" (Metal scrap and plastics), 40% of "inert waste" (concrete, bricks, earths, etc.) and 10% is "special waste" (sludge, pulverulent waste) ;
- Commissioned in August 2003, the CSTFA is implemented in Aube district ;
- Capacity : 650,000 m^3 ; Surface : 45 ha ;
- Operating lifetime : about 30 years, followed by a post-closure monitoring phase of at least 30 years ;
- The waste is deposited in disposal cells excavated in clay. While the repository is in service, waste handling operations are sheltered from rain by removable roofs.
- After the operational phase the waste will be isolated from the environment by a system comprising a synthetic membrane surrounding the waste and a thick layer of clay under and over the disposal cells.

2. Disposal facilities (3/6)

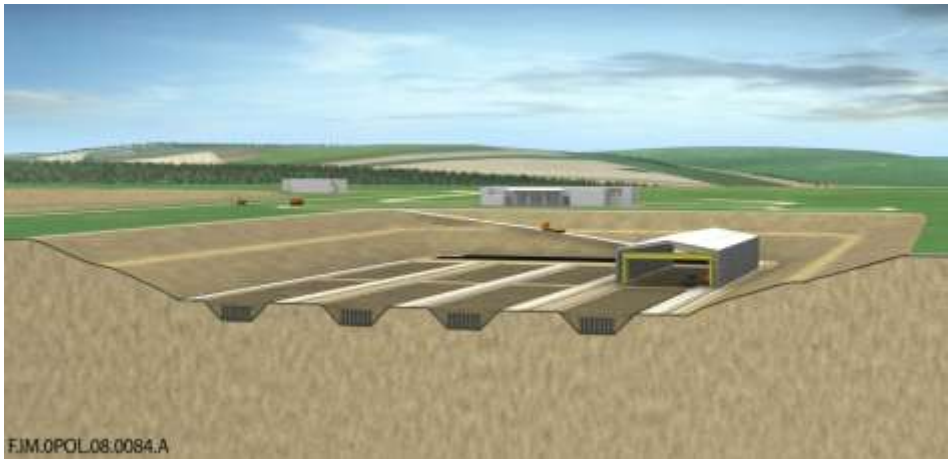
✓ CSFMA :

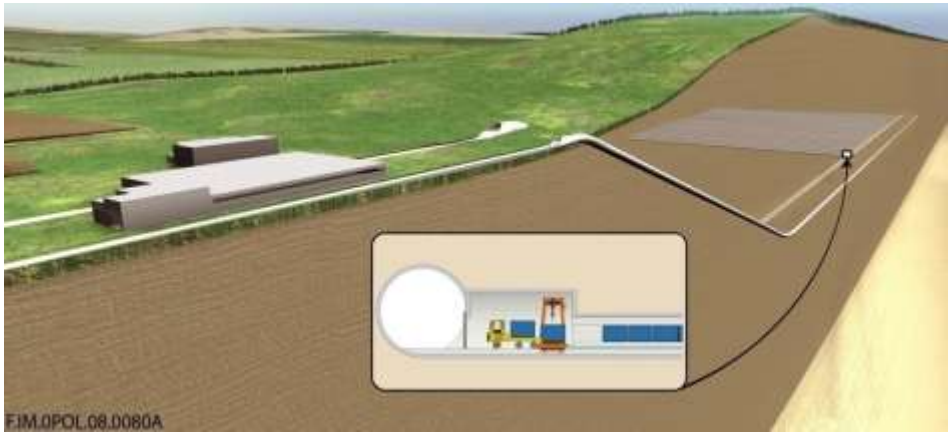
- LILW-SL : 98% from nuclear industry (Filters, water treatment resins, tools, gloves) and 2% from small producers (research lab., hospitals…)
- Commissioned in January 1992, the CSFMA is implemented in Aube district ;
- Capacity : 1,000,000 m^3 ; Surface : 95 ha ;
- Operating lifetime : about 50 years before a 300 years post-closure monitoring period (to benefit from short lived radioactivity decay) ;
- Waste packages are disposed of in reinforced concrete modules 25 m square and 8 m high. The modules are built on an impermeable layer of clay. A layer of sandy soil above the clay drains rainwater off to a single outlet, thus simplifying environmental monitoring.
- Waste packages are protected by moving roofs while the modules are being filled. Once filled, the modules are closed by a concrete slab.
- After the operational phase, a watertight cover will protect the modules.

2. Disposal facilities (4/6)

✓ Repository project at a shallow depth, in a clay layer :

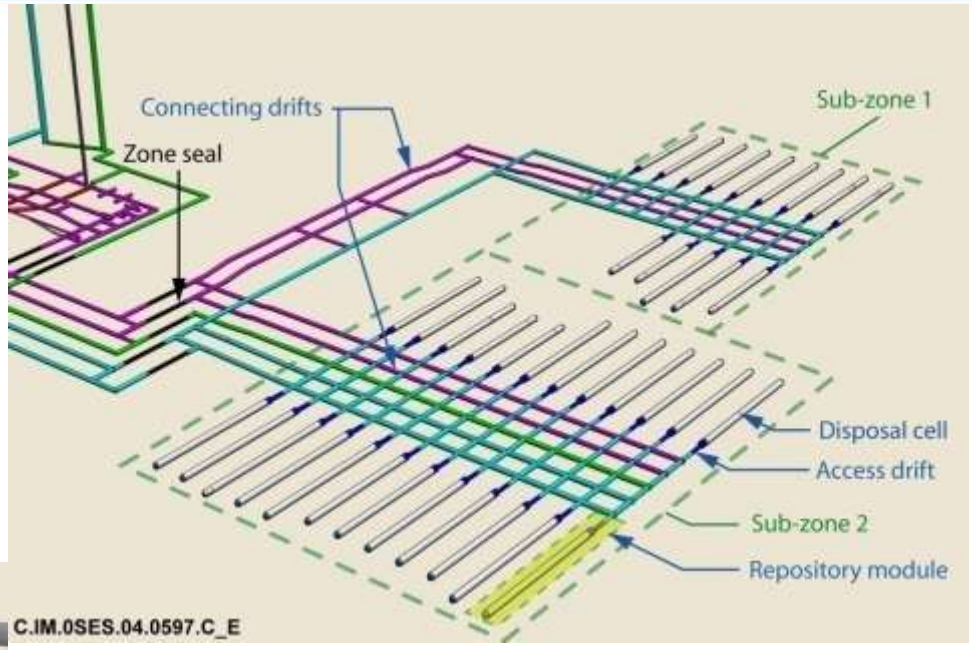
- Designed for LLW-LL such as radium bearing waste
- Long term safety is insured via passive functions available for 10 000 years and more : waterflow limitation, radionuclide immobilization, migration attenuation, isolation from human activities and natural phenomena.
- Two design options are under investigation :
  - 15 to 30m depth ⇒ open pit + restructed clay cover (“SCR”)
  - 50 to 200m depth ⇒ underground drifts (“SCI”)

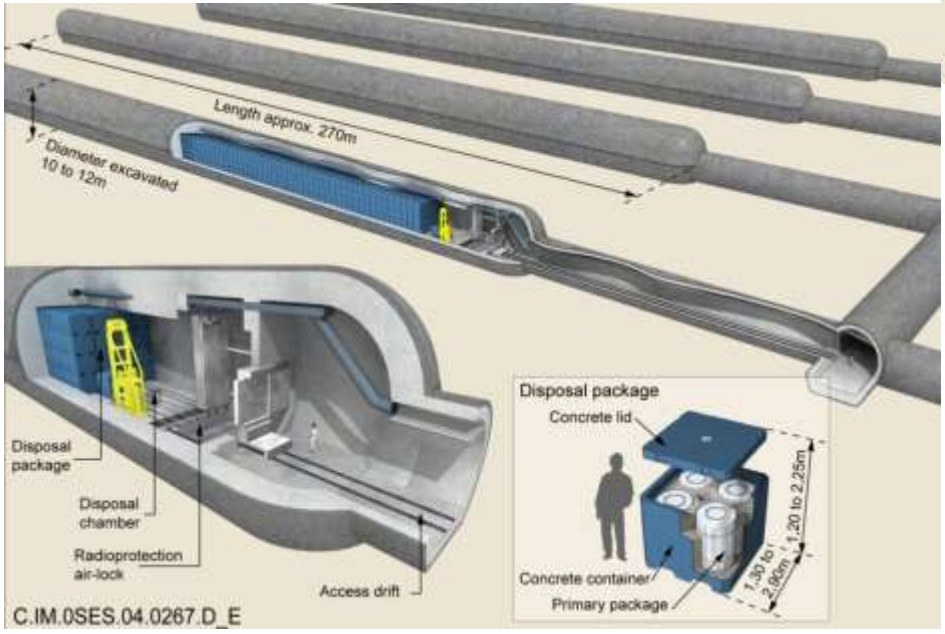




2. Disposal facilities (5/6)

- ✓ Repository project in a deep clay layer :
  - ❖ Passive safety functions after closure ;
  - ❖ Reversibility for at least 100 years ;
  - ❖ Co-disposal of ILW and HLW ;
  - ❖ 500 metres depth.



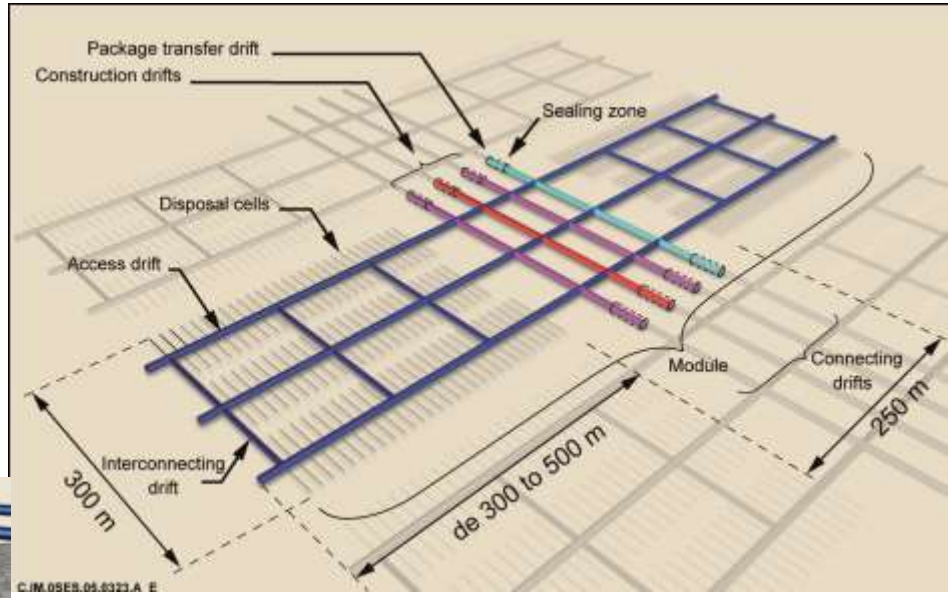


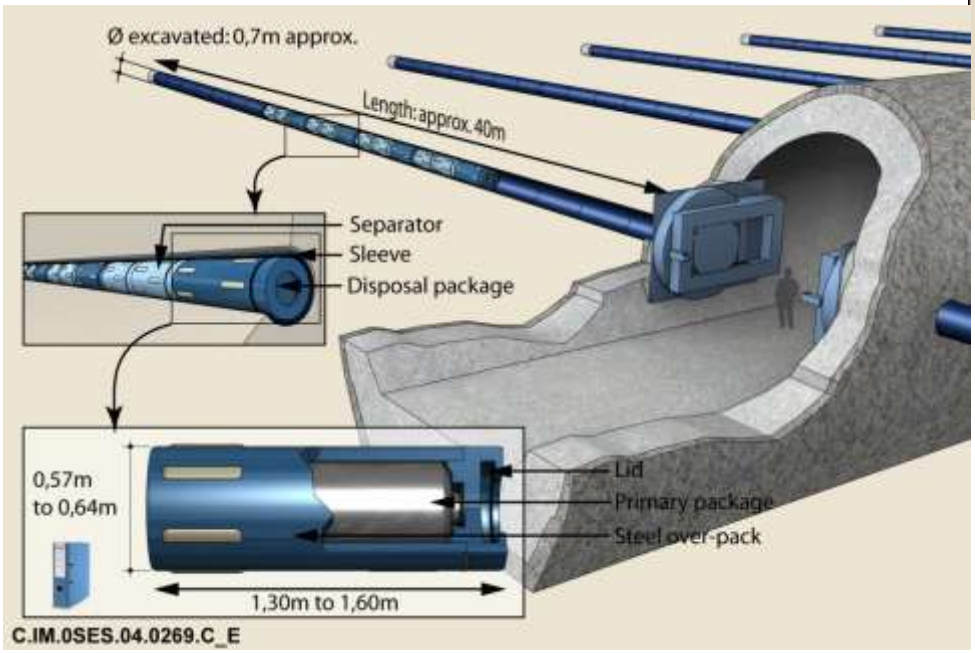
- ✓ Intermediate Level Long Lived Waste :
  - ❖ ILLW-LL : Metal structures surrounding the nuclear fuel and operational residues (waste from effluent treatment, equipment, etc.) ;
  - ❖ Concrete waste disposal packages ;
  - ❖ Large repository vaults.

2. Disposal facilities (6/6)

✓ High Level vitrified Waste :

- ❖ HLW results from the recycling of the spent fuel of nuclear power plants ;
- ❖ Conditioned into a glass matrix and poured into stainless-steel containers.





- ❖ HLW are disposed of in dedicated repository modules ;
- ❖ The design accomodates heat generating waste (up to 500 watts/package).

3. Main disposal parameters (1/7)

Since 2007, CSFMA can accommodate short lived sources

- Examples of sources dealing with the CSFMA :
  - ^{60}Co with pakage activity < 270 TBq ;
  - ^{90}Sr with source activity < 8 MBq ;
  - ^{137}Cs with source activity < 22 MBq.

- The activity thresholds have been defined on the base of technical criteria established for waste and a specific risk related to sources :
  - Attractiveness ;
  - Concentrated radioactive substance.

Source : CERCA

3. Main disposal parameters (2/7)

Long term exposure scenarios for CSFMA

Specific risk of DSRS compared to other radioactive waste

→ Intrusion in the repository after loss of memory (After at least 300 years)

→ Source recovery

↓

Scenarios

Ingest | Take in pocket | Use as a trinket | Destroy

The consistency of the scenarios is related to source dimensions

↓

Source activity limit

LAS is the source activity at the time of its emplacement in the repository, beyond which the radiological exposure in the event of a recovery (after 300 years for CSFMA) will not be acceptable.

➢ **LAS are a function of the DSRS dimensions**

Rn	Half life (y)	Small size		Medium size		Large size	
		LAS (Bq)	Main scenario	LAS (Bq)	Main scenario	LAS (Bq)	Main scenario
^{3}H	12	$7{,}33.10^{14}$	Ingest	$5{,}38.10^{17}$	Destruction	$5{,}38.10^{17}$	Destruction
^{152}Eu	13	$1{,}36.10^{11}$	Ingest	$1{,}49.10^{11}$	Pocket	$1{,}49.10^{11}$	Destruction
^{90}Sr	29	$8.18\ 10^{6}$	Pocket	$8.18\ 10^{6}$	Pocket	$8.16\ 10^{7}$	Destruction
^{137}Cs	30	2.1910^{7}	Pocket	$2.19\ 10^{7}$	Pocket	$2.19\ 10^{8}$	Destruction

3. Main disposal parameters (4/7)

For the other sources which cannot be disposed of in CSFMA :

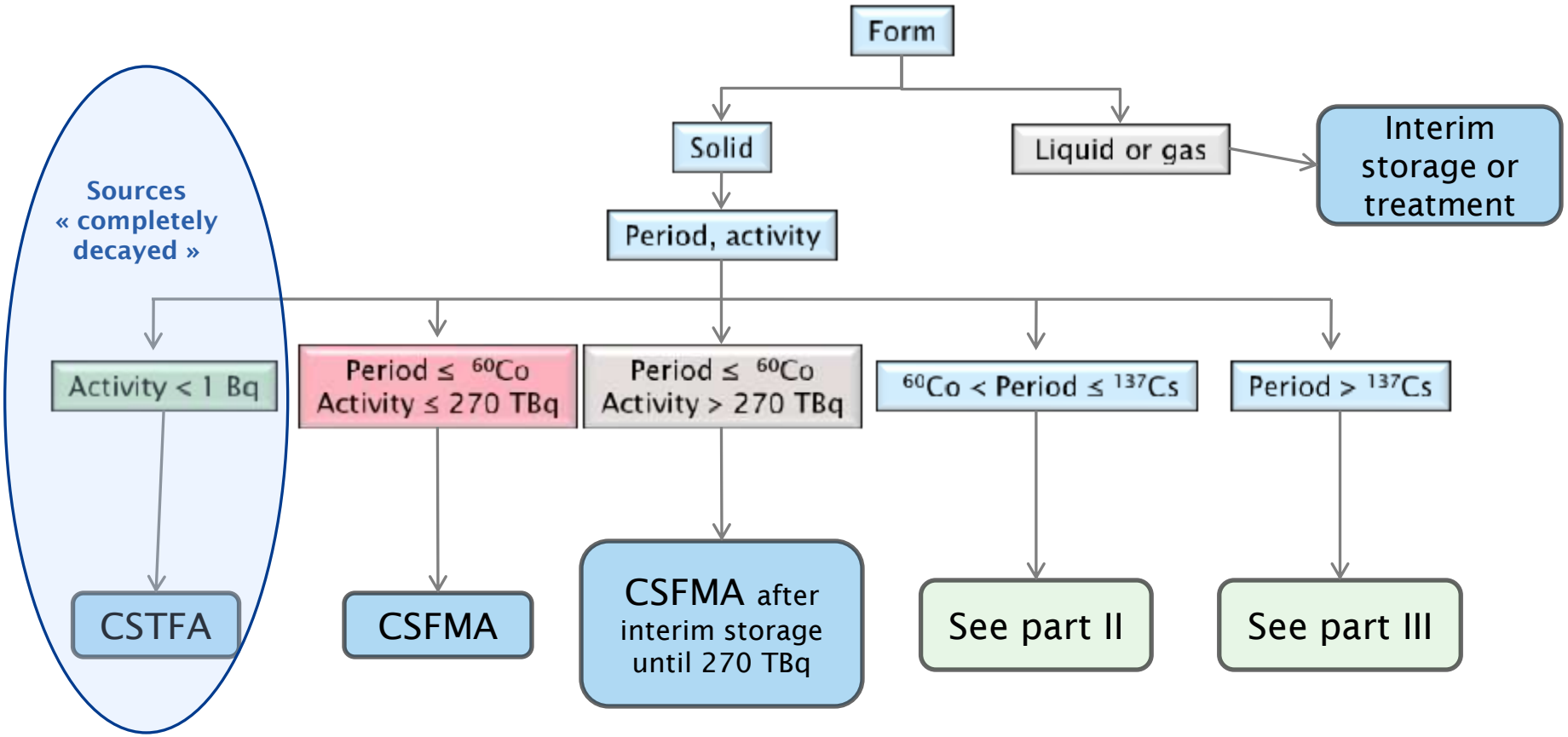
- The LAS approach is extended to shallow depth repositories (15 to 200m).
- No LAS is considered for the deep repository (more than 200m).

The identification of suitable disposal facilities for each type of source is based on the following successive criteria :

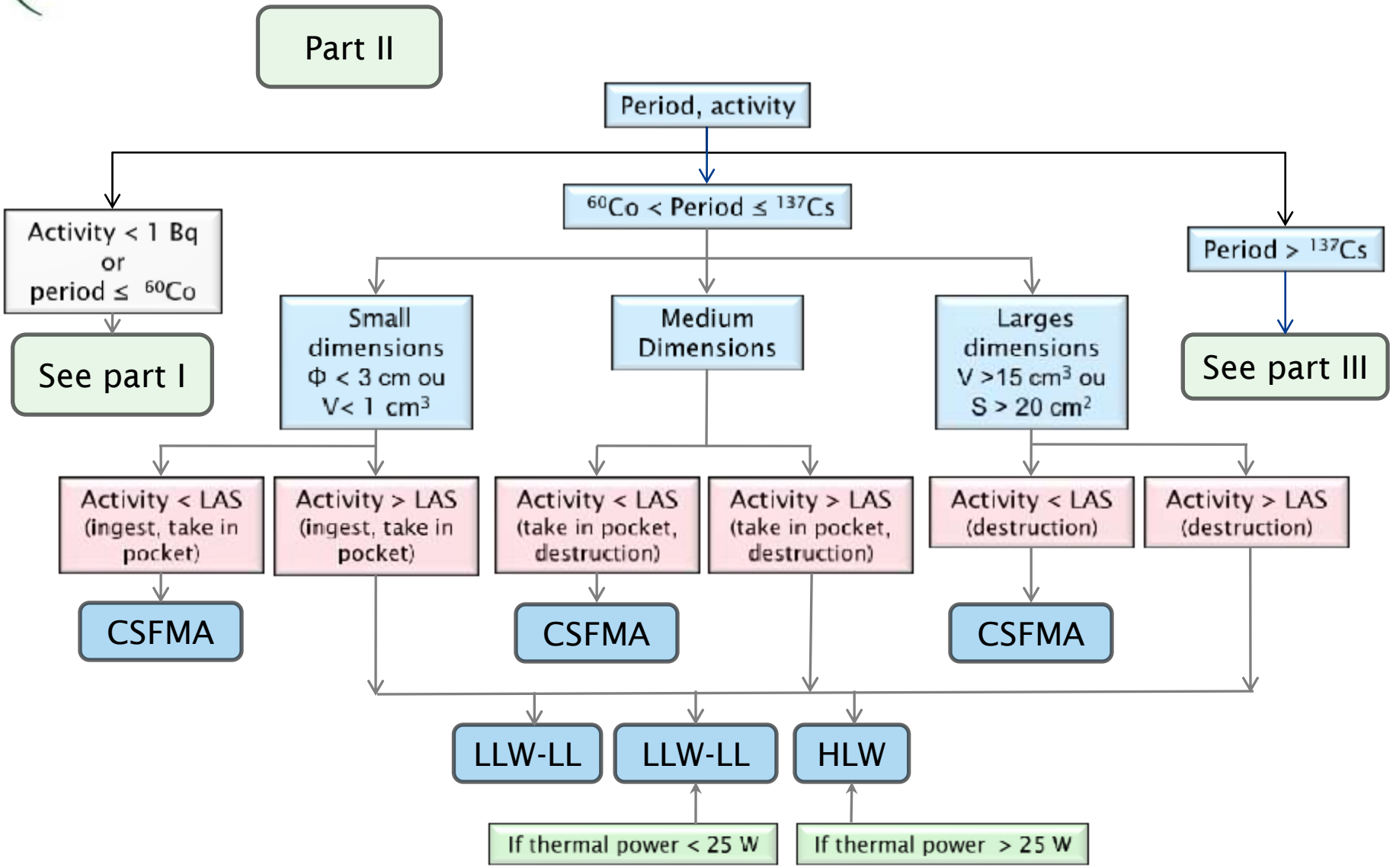
- Form (solid, liquid ou gas) ;
- Period, activity, radionuclide ;
- Compatibility with the other disposal parameters :
  - thermal power ;
  - chemical nature…

3. Main disposal parameters (5/7)

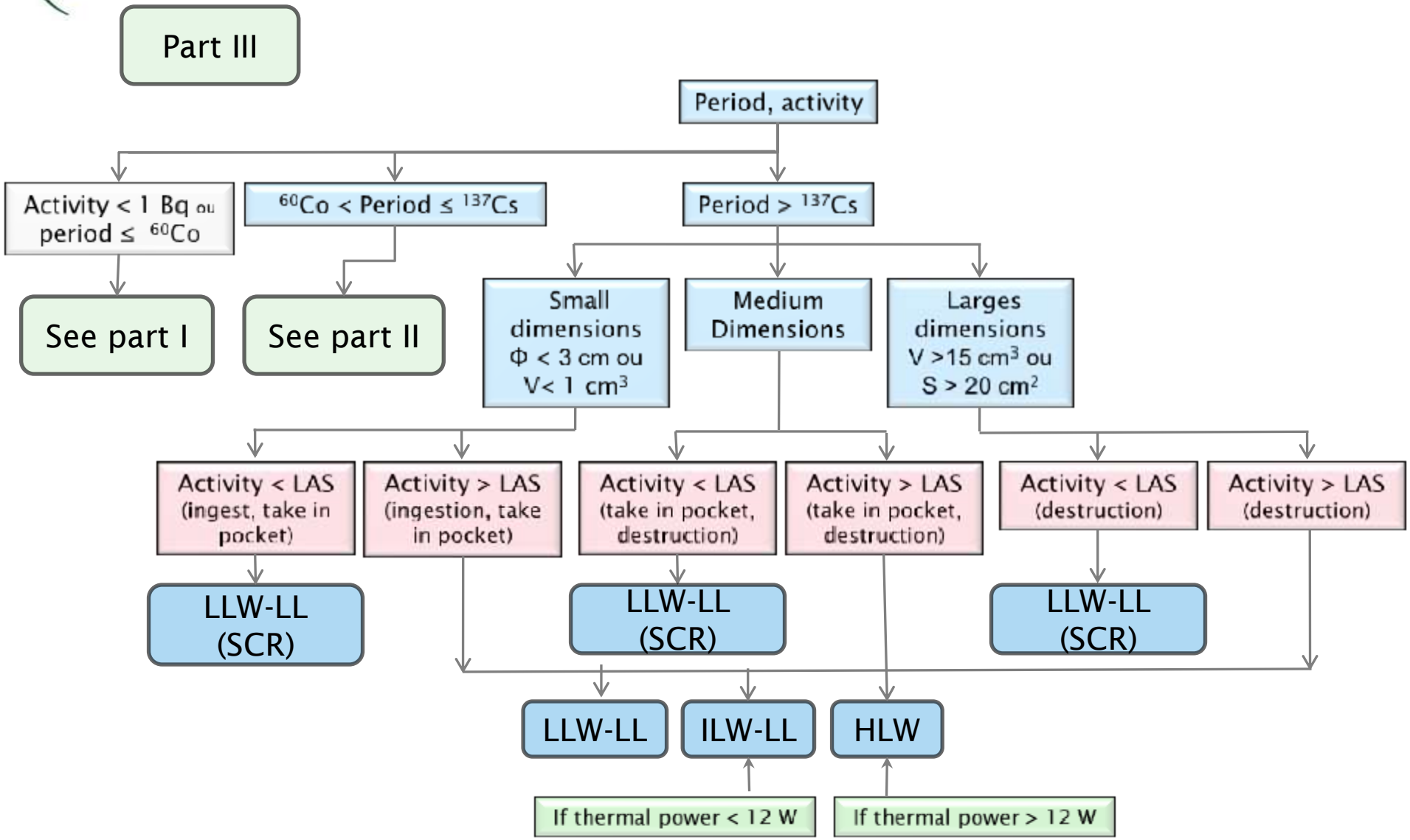
Management routes : part I



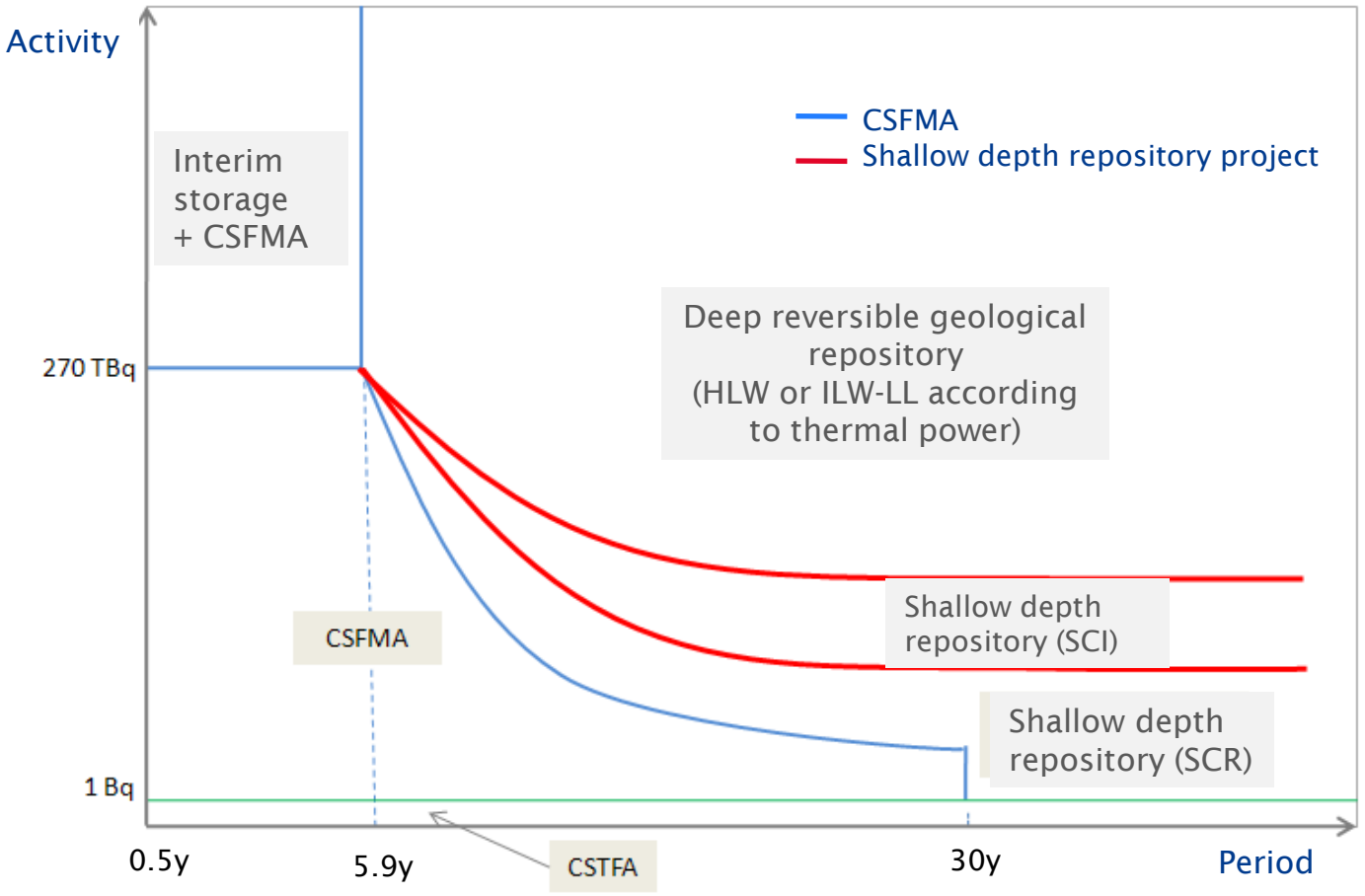
3. Main disposal parameters (6/7)



3. Main disposal parameters (7/7)



General scheme for the DSRS long term management

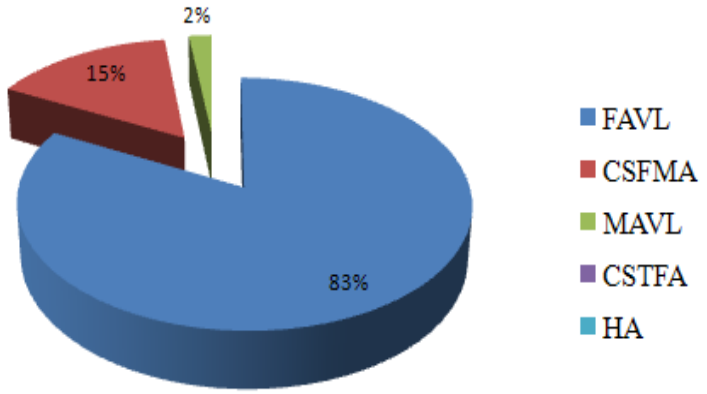


4. DSRS management scheme (2/3)

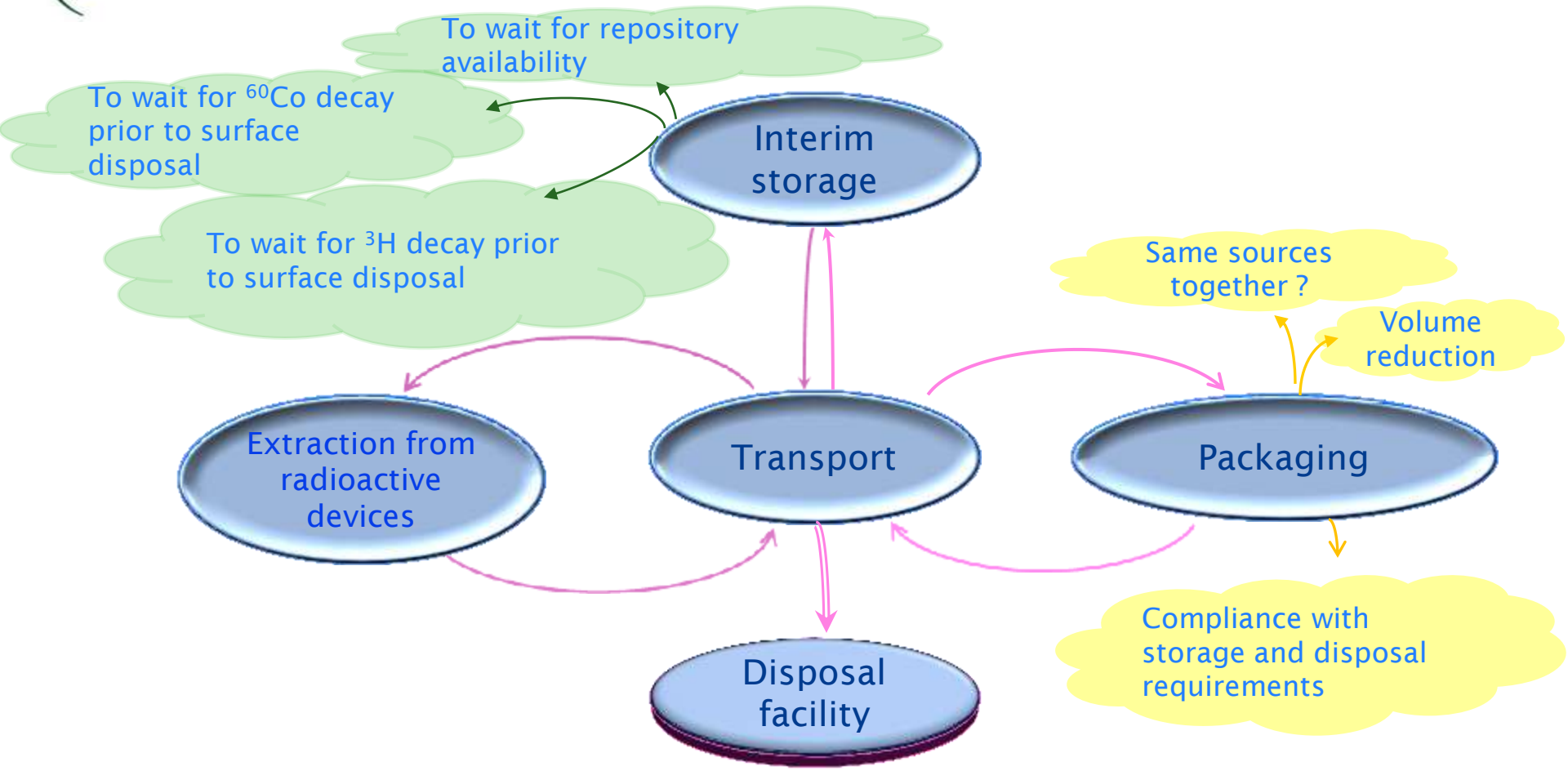
General management routes :

The proposed repositories allow handling DSRS in their initial form without physical change :

- CSTFA :
  - Sources completely decayed (^{57}Co, ^{68}Ge…).
- CSFMA :
  - Sources of ^{60}Co, ^{90}Sr, ^{137}Cs.
- Shallow depth repository project :
  - Smoke detectors ;
  - Surge protectors ;
  - Lightning rods ;
  - Sources of ^{233}Pa, ^{244}Cm, ^{252}Cf ;
  - Sources short lived but non acceptable in CSFMA.
- Deep reversible geological disposal facility :
  - Sources HLW of ^{90}Sr, ^{137}Cs ou ^{241}Pu ;
  - Sources LL ^{239}Pu, ^{240}Pu, ^{242}Pu, ^{232}Th, neutronics ;
  - Radium needles.



4. DSRS management scheme (3/3)



To build a global scheme of DSRS long term management from recovery to disposal will allow anticipating the constraints of every management step and their consequences on disposal.

Thank you

Andra's headquarter