



# DISUSED SEALED RADIOACTIVE SOURCES DISPOSAL IN FRANCE

Meeting on Security of Disused  
Radioactive Sources

Vienna, October 9<sup>th</sup> 2019

Andra : Flavien TETART



# Andra

## French radioactive waste management organization

Independent from the waste generators

Placed under the supervision of the ministers in charge of Research, Energy and the Environment

Responsible for the **long-term management** of all radioactive waste produced in France

It involves about 650 employees (2/3 engineers and managers) and a budget of 325 M€

Funding: mainly by radioactive waste producers on a commercial basis for waste packages delivered to our sites, or through a tax the geological disposal R&D

**The Planning Act of 28 June 2006 concerning the sustainable management of radioactive materials and waste provides the framework for Andra's action**

# Andra's main facilities



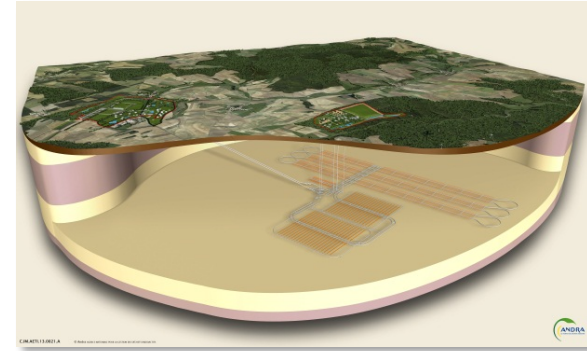
## VLLW disposal « CIRES »

- Disposal capacity: 650.000 m<sup>3</sup>
- Mainly dismantling waste
- No clearance level in France
- + activities in support of non electronuclear waste generators



## LILW disposal « CSA »

- Disposal capacity: 1.000.000 m<sup>3</sup>
- ILW: only short live
- Mainly exploitation waste from nuclear power plants
- Capacity sufficient for the current NPP fleet



## Project Cigéo : HLW & ILW disposal

- 2 quarters ~ 500 m depth
- Disposal capacities
  - ILW: 75.0000 m<sup>3</sup>
  - HLW: 10.0000 m<sup>3</sup>
- Underground laboratory in operation
- Commissioning ~ 2030

# Context and strategy for DSRS disposal



# Context

CEA and Cisbio: former major manufacturers and suppliers

- Including high activity SRS
- Last SRS supplied in 2006
- Currently, only return and conditioning

LEA (Orano group) is the last french manufacturer

- Manufacturing: only low activity SRS

All other SRS distributed today in France are imported and, normally, re-exported

Working group between stakeholders (ministry, regulator, TSO, WMO, suppliers, ...) for the long term management of DSRS

- Integrated to the National plan on management of radioactive materials and waste (PNGMDR)

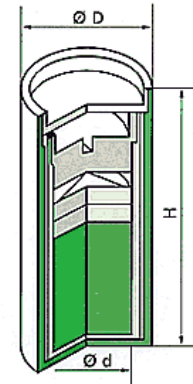
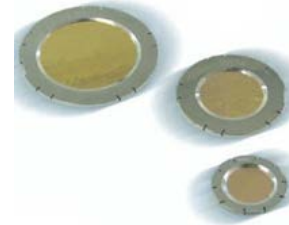


Interim storage (Cisbio)

# DSRS inventory

Estimation between 2 and 3 millions of DSRS

- Most of them are smoke detector sources
- From exempted calibration sources to  $^{60}\text{Co}$  and  $^{137}\text{Cs}$  high activity sources



COT

**But very few volume compared to disposal capacities !**

Forecasts for the first decade (including accumulated stocks):

Disposal route	Type of disposal package	Number of packages (stock)	Number of packages (traffic in 10 years)	Total number of packages	Total volume of packages in repository (m <sup>3</sup> )
VLLW	Basket 1 m <sup>3</sup>	6	17	23	23
LLW/ILW – SL	Package 5 m <sup>3</sup>	31	21	53	265
ILW-LL (CIGEO) or LLW-LL	Package 870 l	78	61	139	121
	CSM packages stored by CEA	41	0	41	123
HLW-LL	CDT 175 l	6	1	7	1,2

Disposal capacity [m<sup>3</sup>]

650.000

1.000.000

75.000.000

10.000.000

# Radioactive sources - Regulatory framework

**Public health regulation:** distribution, use, return to supplier, ...

- National SRS inventory kept by IRSN : import/export, distribution, return, ...
  - For in-use SRS -> Not an inventory of DSRS
- Users have to organise and pay the return of DSRS
- Suppliers distributing in France have to provide a return service and manage safely DSRS: return to supplier/matrix, recycling, disposal
- Financial guarantee

**Environment regulation:** disposal

- DSRS considered as waste when the decision of disposal is made
  - Supplier/matrix become a waste producer
- No specific regulation for DSRS compared to other radioactive waste
  - Just an exception to enable import and export for return to supplier
- Waste producer is responsible for characterization, conditioning, cost,

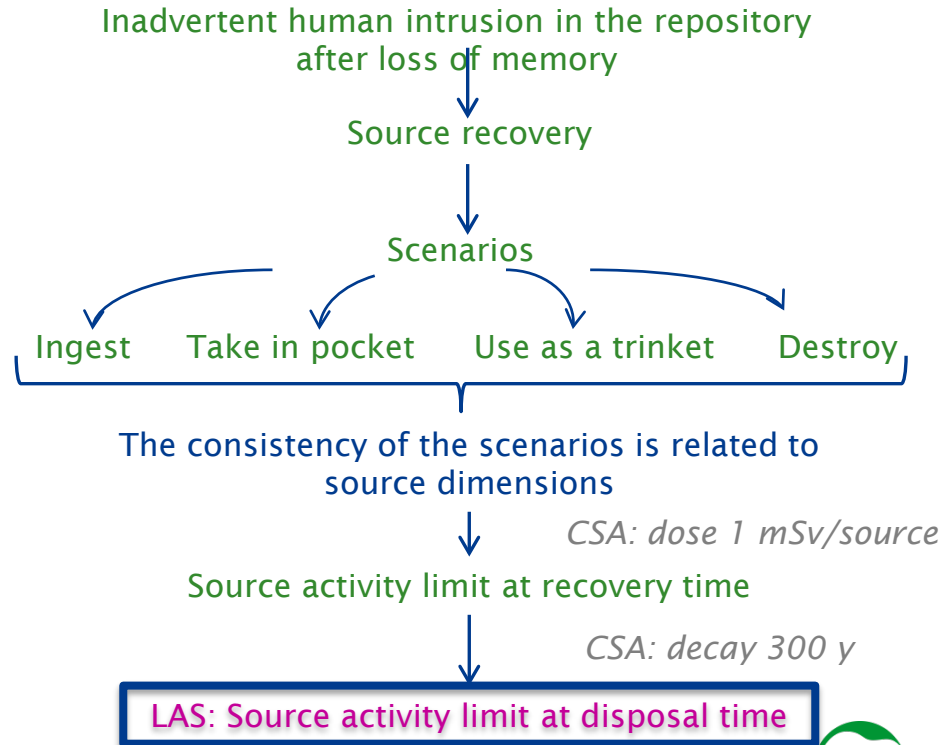
# Specificities of DSRS for disposal

Compared to other radioactive waste, DSRS present two specificities for disposal:

- In operation: “hot points” for exposure in case of accidental situations (fall, ...)
- In post-closure: risk of recovery in case of inadvertent human intrusion
  - Sources are potentially attractive and durable



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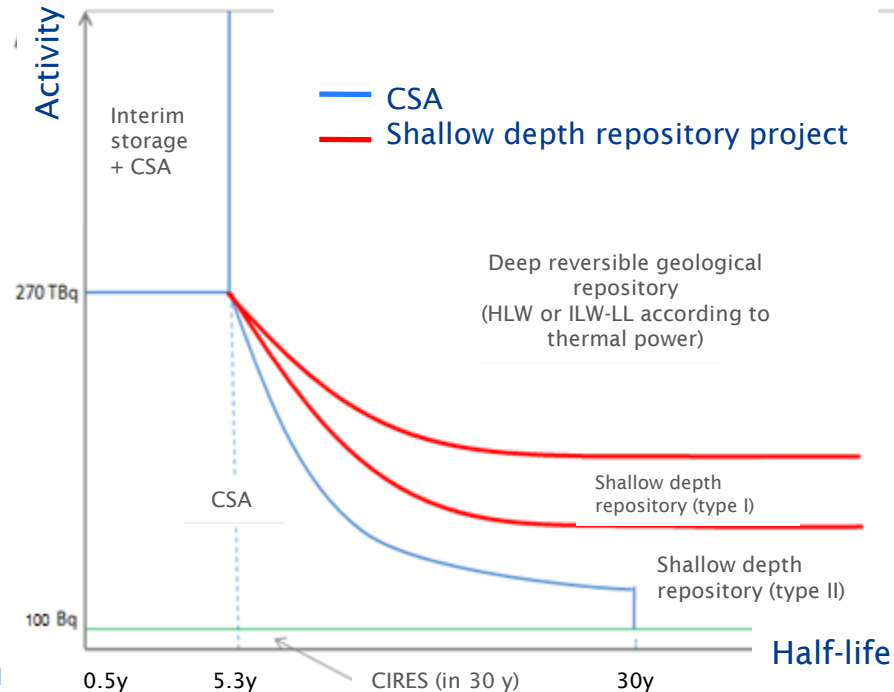


# Strategy for long term management

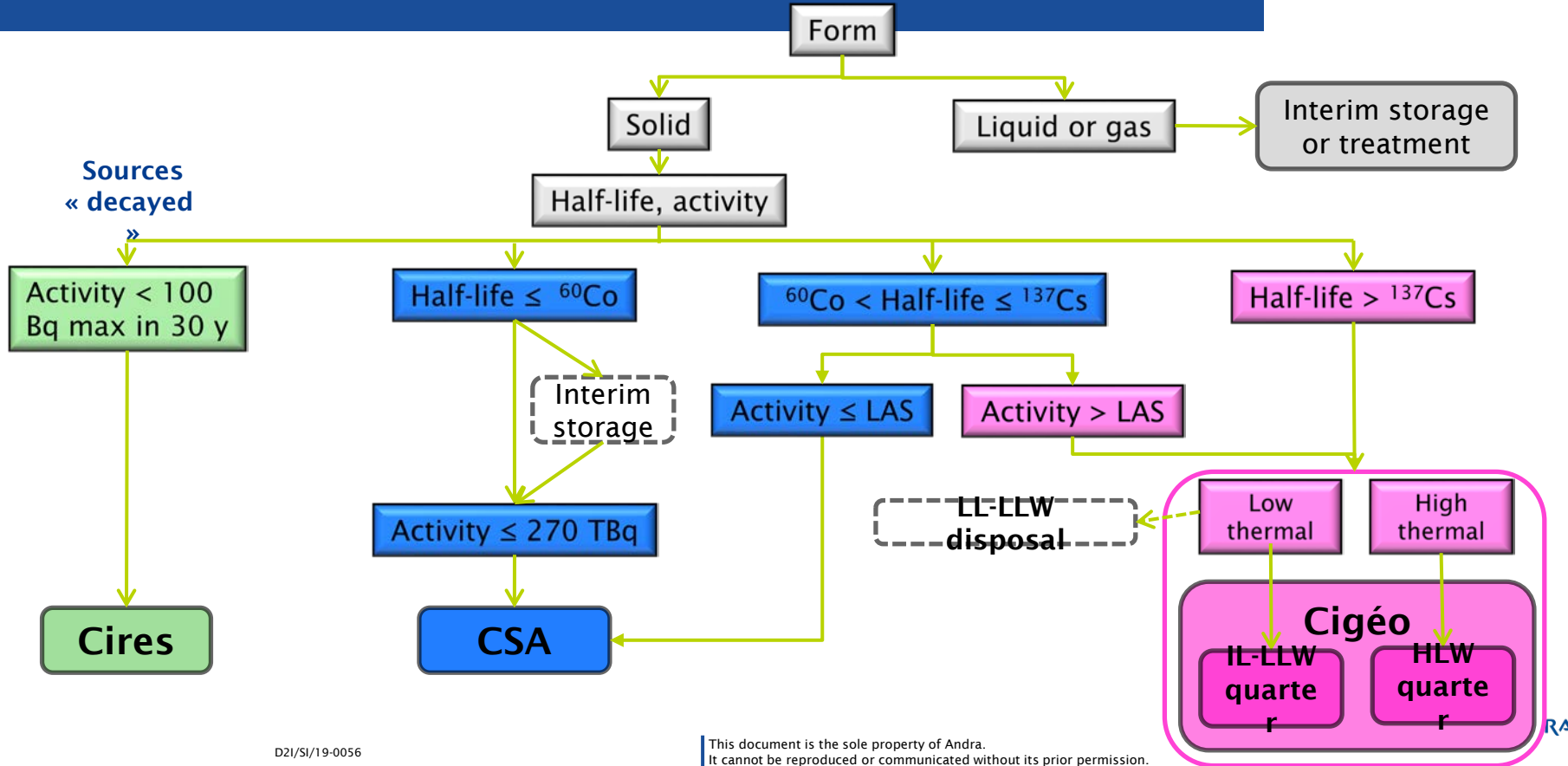
Use of existing or planned repositories

Choice of the suitable repository driven by the **activity / half-life** couple, considering **post-closure safety**:

- **Cires** for totally decayed sources after institutional control period (30 y)
- **CSA** for short life sources ( $T_{1/2} < 30$  y) if residual activity after institutional control period (300 y) complies with safety scenarios
- **Cigéo** in other cases
- In optimization, LL-LLW shallow depth repository for long life sources complying with safety scenarios



# Strategy for long term management





# Near surface disposal

## CSA and Cires

# DSRS disposal in CSA (LLW repository)

Since 2007, CSA has started disposal of short lived sources

Examples of sources dealing with the CSA:

- $^{60}\text{Co}$  with package activity  $\leq 270 \text{ TBq}$ 
  - Ex:  $^{60}\text{Co}$  cat 1&2 sources after decay
- $^{90}\text{Sr}$  with source activity  $\leq 8 \text{ MBq}$
- $^{137}\text{Cs}$  with source activity  $\leq 22 \text{ MBq}$

Main acceptance criteria specific to sources:

- Half-life  $\leq 30 \text{ years}$
- Operational safety: package activity  $\leq 270 \text{ TBq}$
- Post-closure safety: source activity  $\leq \text{RN-dependant limits (LAS)}$ 
  - No LAS for  $^{60}\text{Co}$  (decay sufficient)



# DSRS disposal in CSA (LLW repository)

Some values of LAS for the CSA :

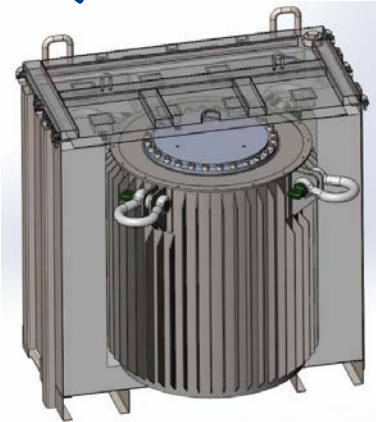
Rn	Half life (y)	Small size		Medium size		Large size	
		LAS (Bq)	Main scenario	LAS (Bq)	Main scenario	LAS (Bq)	Main scenario
$^{133}\text{Ba}$	11	$2,55.10^{13}$	Ingest	$6,79.10^{13}$	Pocket	$6,78.10^{14}$	Destruction
$^{152}\text{Eu}$	13	$1,36.10^{11}$	Ingest	$1,49.10^{11}$	Pocket	$1,49.10^{11}$	Destruction
$^{90}\text{Sr}$	29	$8.18 \cdot 10^6$	Pocket	$8.18 \cdot 10^6$	Pocket	$8.16 \cdot 10^7$	Destruction
$^{137}\text{Cs}$	30	$2.19 \cdot 10^7$	Pocket	$2.19 \cdot 10^7$	Pocket	$2.19 \cdot 10^8$	Destruction

Half-life  $\leq 5,27$  years ( $^{60}\text{Co}$ ): no LAS

# DSRS Disposal in CSA (LLW repository)

Example:  $^{60}\text{Co}$  sources returned to CEA/Cisbio:

- Dismantling of devices in hot cells by CEA/Cisbio
- Sources collected in stainless capsules
- Disused transport package used for radiological shielding
- Cemented  $5\text{m}^3$  packages produced on disposal site



# DSRS Disposal in CSA (LLW repository)

Operations started in August 2019



# DSRS Disposal in CSA (LLW repository)





# DSRS disposal in Cires (VLLW repository)

Since 2013, Cires has started disposal of DSRS

- Activity < 100 Bq after 30 years decay for most RN
  - Arbitrary but conservative, even in the worst scenario
- In practice, only decayed sources
  - Short-live source :  $^{57}\text{Co}$ ,  $^{68}\text{Ge}$ , ...
  - Ex:  $^{57}\text{Co}$  sources for imaging calibration
- No specific packaging



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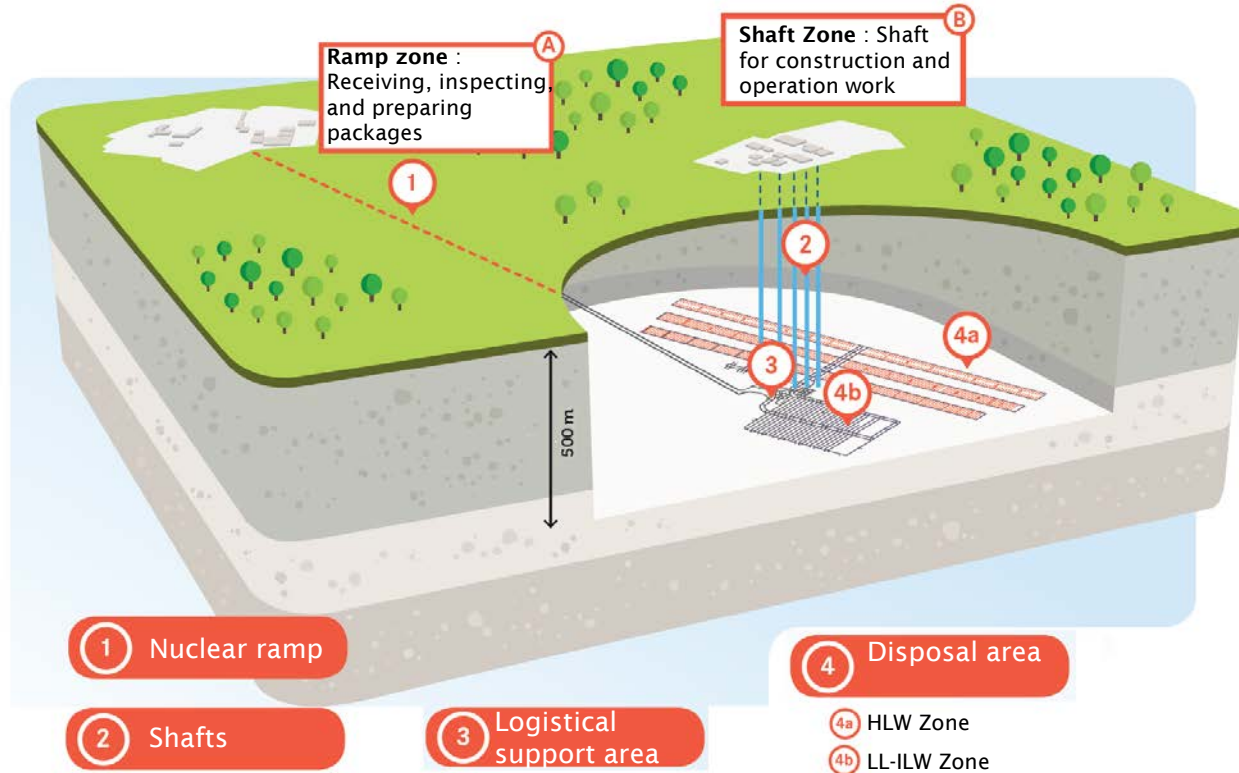
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# Deep Geological disposal

## Project Cigéo

# Overview of Cigéo facilities



# Safety in Cigéo

## Operational safety:

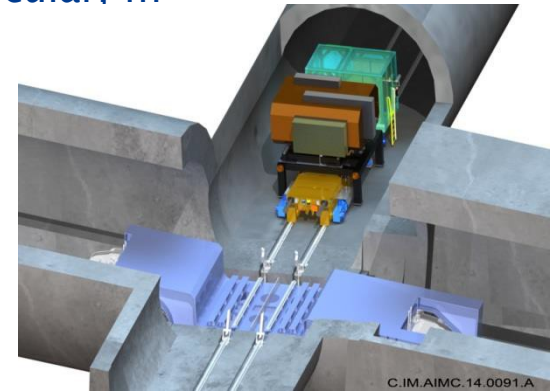
- DSRS packages managed like other radioactive waste packages
- Automated process, few human interventions
- Containment provided all along the process
- Make handling operations safe : rail transfer, funicular, ...

## Post-closure safety:

- Recovery of DSRS is unlikely (depth ~ 500 m)
- No criteria for limiting activity of DSRS

**DSRS packages characteristics are included in the set of other waste packages**

**-> No specific design or criteria for the disposal of DSRS packages in Cigéo.**



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# Examples of DSRS packages for Cigéo

## Cigéo ILW (eventually LL-LLW repository)

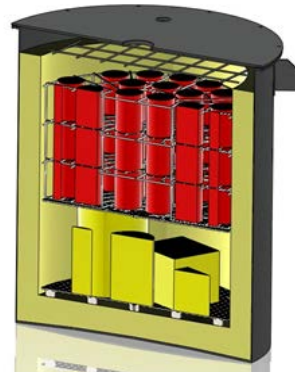
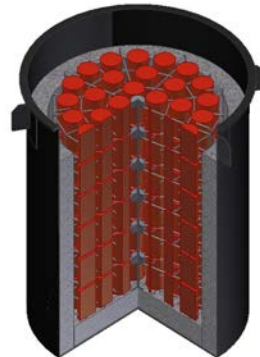
For low thermal DSRS not allowed at CSA

- Ex :  $^{239}\text{Pu}$ ,  $^{241}\text{Am}$ ,  $^{226}\text{Ra}$ , smoke detectors sources, neutron sources, RTG, ...
- Sources collected in stainless boxes
- « Multi-purpose » 870 L cemented package designed for both Cigéo ILW quarter or LL-LLW repository
- Adapted for devices which cannot be dismantled (Alcyon, RTG, ...)



1 L

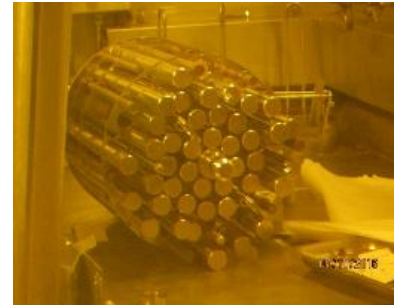
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## Cigéo HLW

For high thermal DSRS

- Ex:  $^{137}\text{Cs}$  HA sources
- Sources collected in stainless capsules
- 200 L welded package designed for Cigéo HLW quarter



# Conclusion

For Andra's repositories:

- Specific criteria for near surface disposal
  - Especially for taken into account recovery scenarios
- DSRS are considered as standard radioactive waste in Cigéo
  - No specific criteria

In France, in operation or planned repositories for other radioactive waste are sufficient for the disposal of DSRS

- Very small volumes compared to other radioactive waste
- No need of specific repository for DSRS in France
  - Strategy adapted to an electro-nuclear country. Other strategies exist in different countries (boreholes, ...).



# Thank you for your attention

## Time for questions

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