Cires : Characteristics, Concept, Safety and Waste Acceptance Criteria

SCIENTIFIC SEMINAR IN THE FRAMEWORK OF « PALDISKI » PROJECT »

John Muller, CSA Safety Department

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Summary

1. Industrial facility for grouping, storage and disposal (Cires)

1.1 Capacities and characteristics

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Type of installation : Installation classifed for the environment protection (ICPE)

Disposal facility started up in : 01/10/03

Superficy : 45 hectares with 29 reserved for the disposal

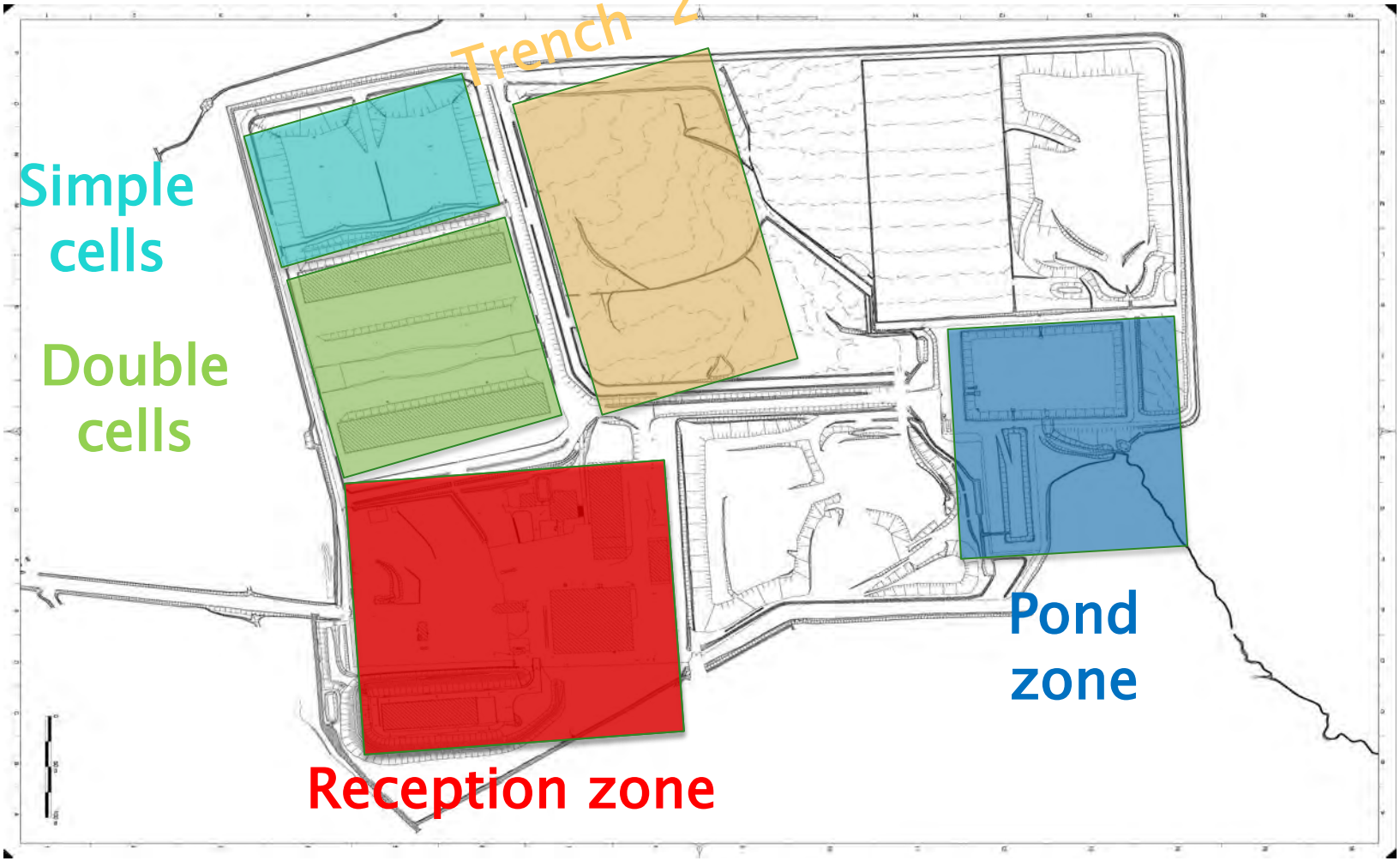
Disposal capacity : 650.000 m^3

Duration of operation : 30 years plus monitoring

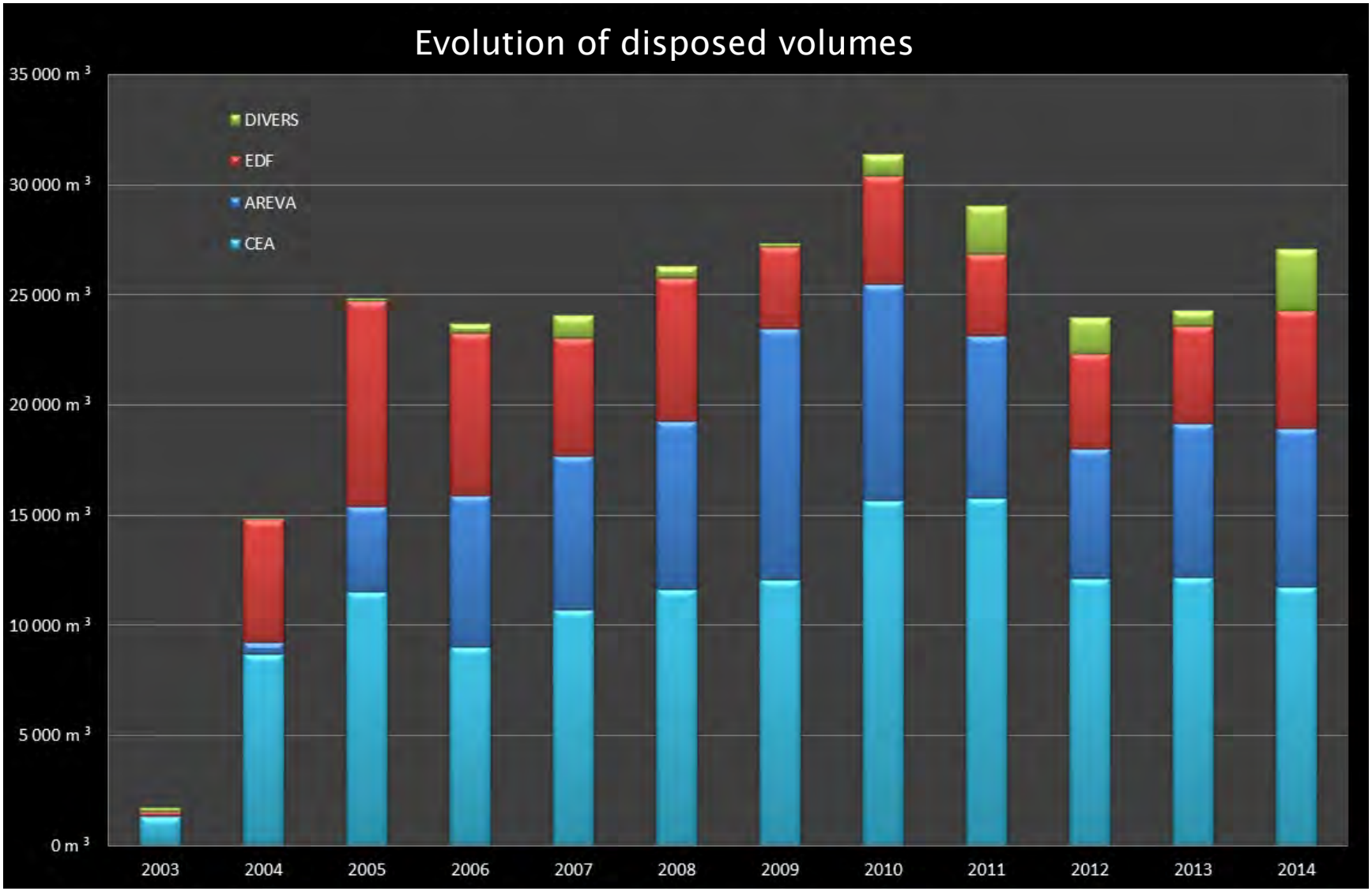
2 new activities (autumn 2012) :

- Grouping
- Storage of non nuclear power radioactive waste

1.1 Capacities and characteristics



1.1 Capacities and characteristics



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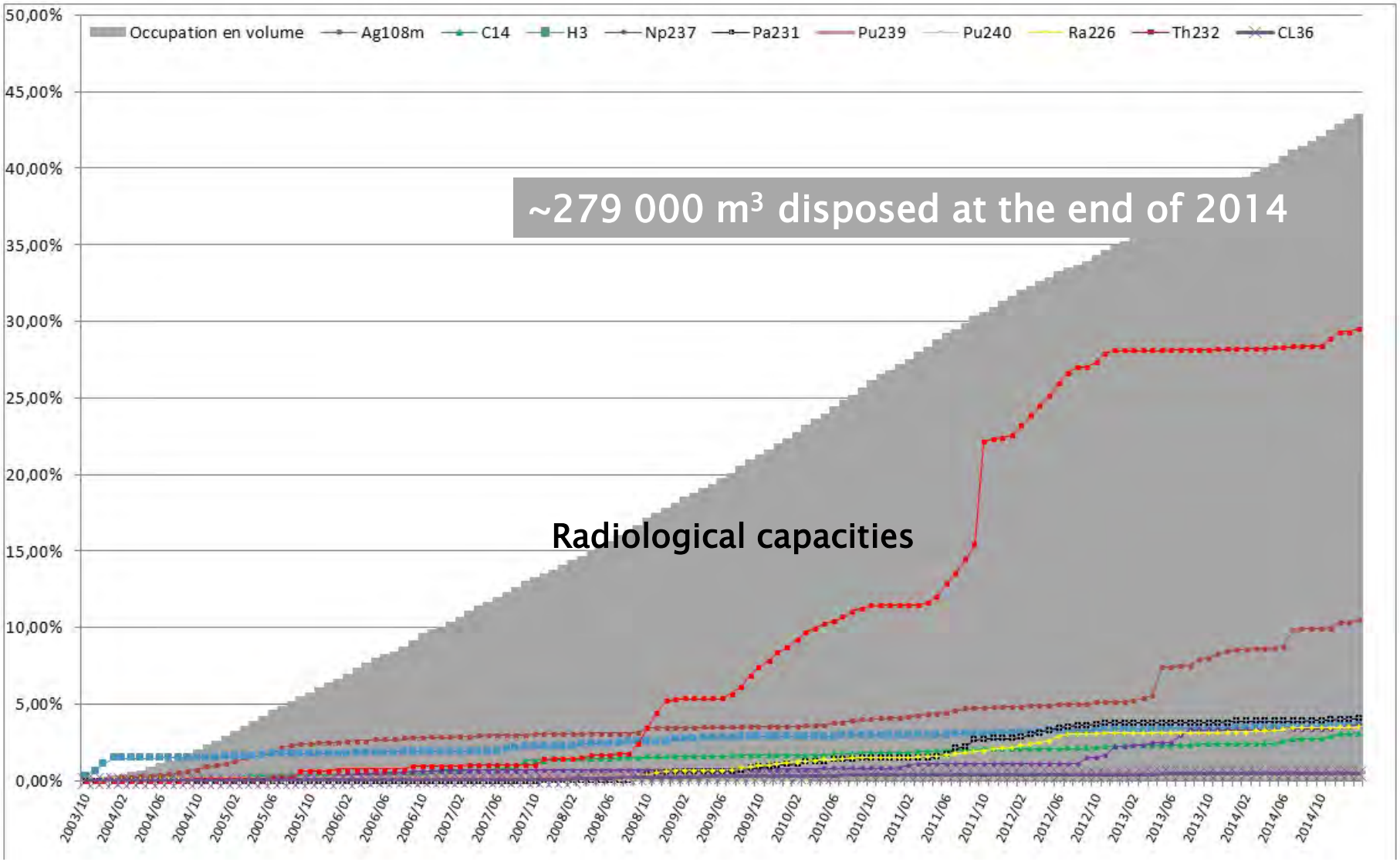


1.1 Capacities and characteristics

Grouping facility 550m² :

- Waste reception
- Temporary storage of waste packages
- Packaging of certain waste
- Waste expeditions towards installations of elimination (incineration) or treatment (compaction) before directing this waste to the disposal cell or to the storage
- Management of the empty packages

About 4 000 to 5 000 packages are managed yearly

1.1 Capacities and characteristics

Storage facility 2000 m² :

- Temporary reception of non nuclear radioactive waste which has yet no dedicated disposal facility
- 500 - 1 000 m^3 of waste per year during the first two years (period of transfer of waste stored in existing installations) and 250 m^3 of waste per year after that (average)

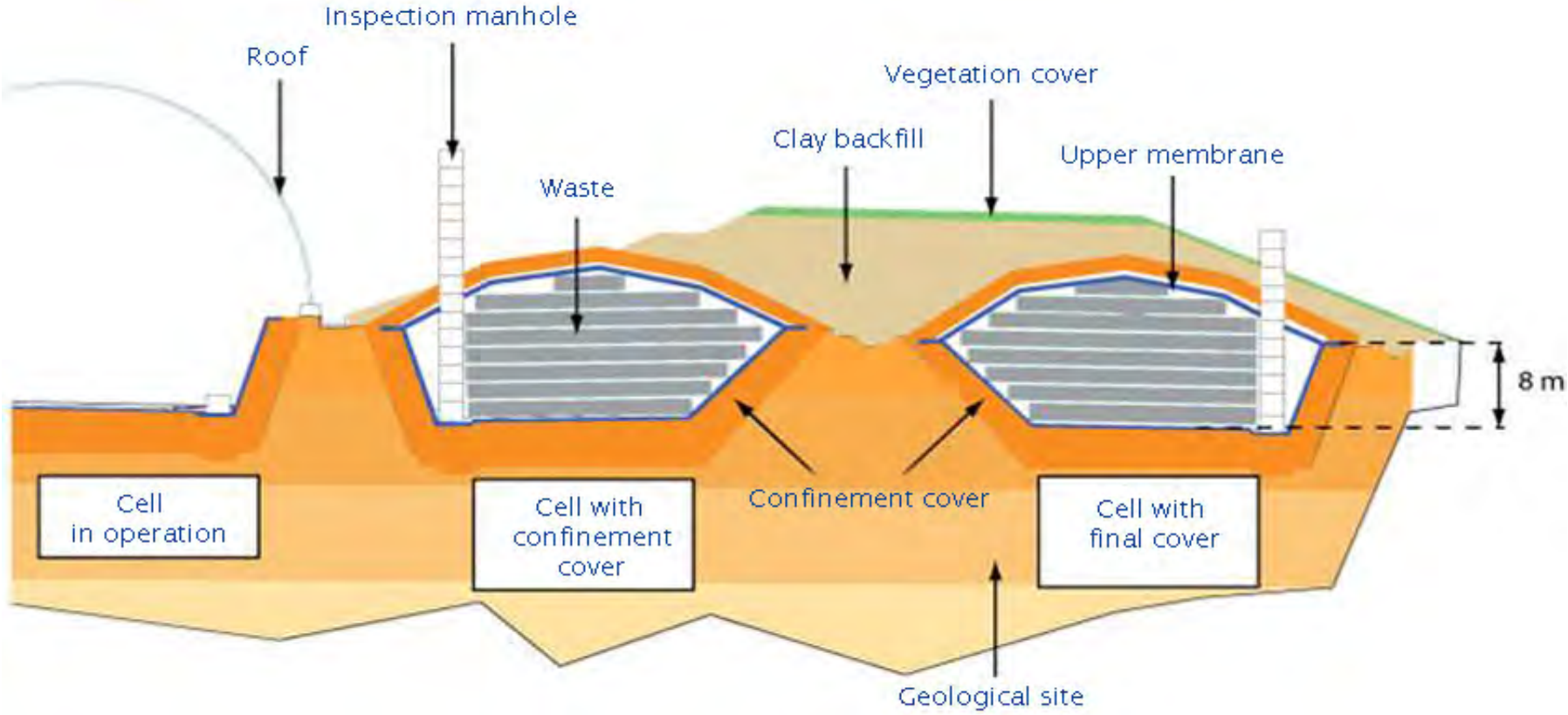
1. Industrial facility for grouping, storage and disposal (Cires)

1.2 Disposal concept

1.2 Disposal concept

Containment is ensured by two barriers :

- A waterproof high density polyethylene geomembrane
- Clay materials naturally present (geological formation)



1.2 Disposal concept

During operation, waste is disposed of under a waterproof roof

1.2 Disposal concept

Dimensions of simple cells (n°1 to 6) : 80 m x 30 m x 8 m
Dimensions of double cells (n°7 to…) : 180 m x 30 m x 8 m

Volume of simple cells (n°1 to 6) : between 11 000 and 13 000 m^3
Volume of doube cells (n°7 to…) : between 28 000 and 34 000 m^3

During the operation of the Cires from 2003, several optimizations have been implemented in order to gain volume in the cell :

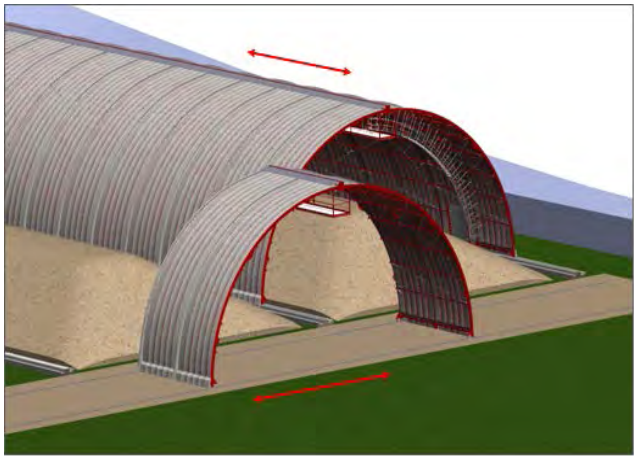
- ✓ Cell dimensions
- ✓ Cell slopes
- ✓ Disposal of waste on the top (after the ground level = dome)

1.2 Disposal concept

Previous concept for the roof :

- Very long operation for the displacement of the roof
- Height work for the displacement and the maintenance
- Expensive operation

1.2 Disposal concept

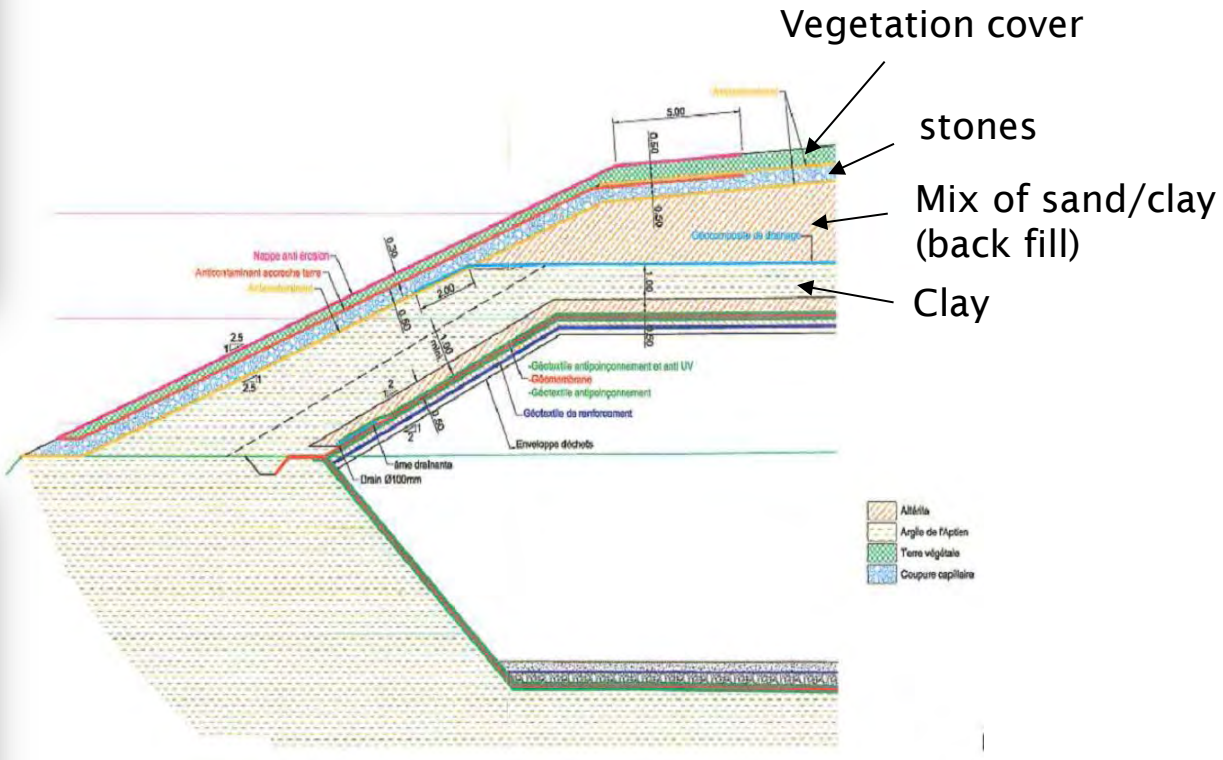


New concept for the roof : Prémorails (Andra patent)

- 18 independant sections (modular)
- Sections are displaced by network of ledger lines
- Reduces the time for the displacement
- Reduces the cost of the displacement
- No height work : walkway in the upper part of the cell

1.2 Disposal concept

Final cover :



1.2 Disposal concept

Creation of a new dedicated cell for large disused components

<u>Why ?</u> A standard cell has insufficient flexibility to accommodate large components

- Need to wait that loading operation is at the ground level (level 0)
- Constraints on other waste streams:
  - Stringent planning of prior deliveries of large components
  - Standard waste deliveries are reduced for 3 to 4 weeks

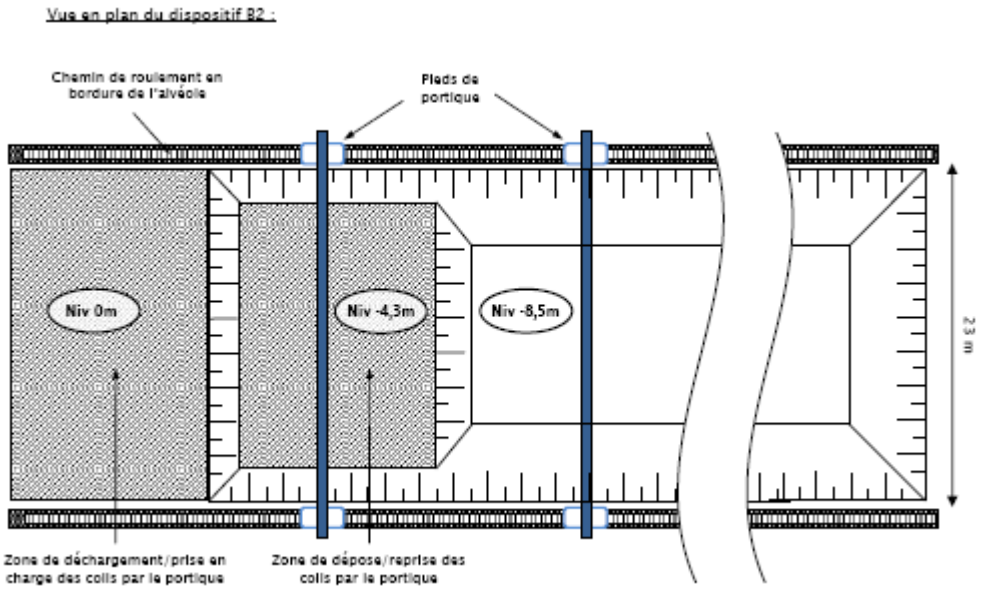
A need for heavy handling tools that are better adapted to large components

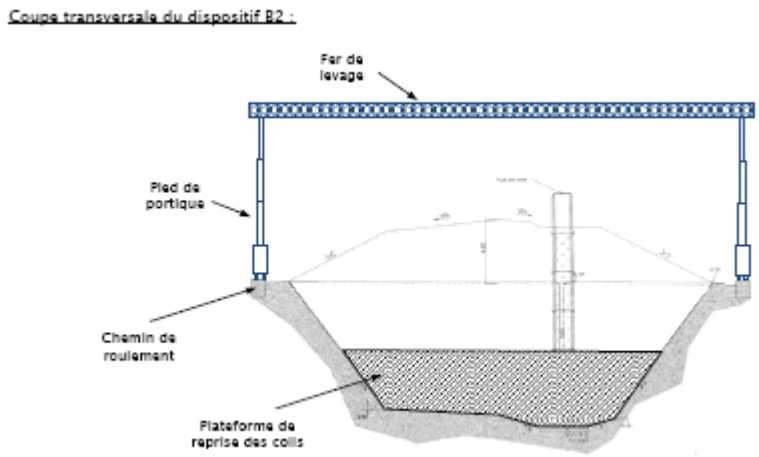
➔ Andra needs a dedicated cell to enable a safe industrial disposal of large components

1.2 Disposal concept

Such specific cell will also accommodate 10- and 25 ton- packages that are presently disposed of in standard cells. It will also accommodate standard packages in order to fill the voids.

Start up in 2016





2. Standard management of waste packages on the Cires

2. Standard management of waste packages on the Cires

Containers are transferred to the logistics facility
Handling capacity : 32 tons
Number of containers per day : 26 containers or 16 deliveries

2. Standard management of waste packages on the Cires

Containers are transfered from the storage area to the unloading zone

2. Standard management of waste packages on the Cires

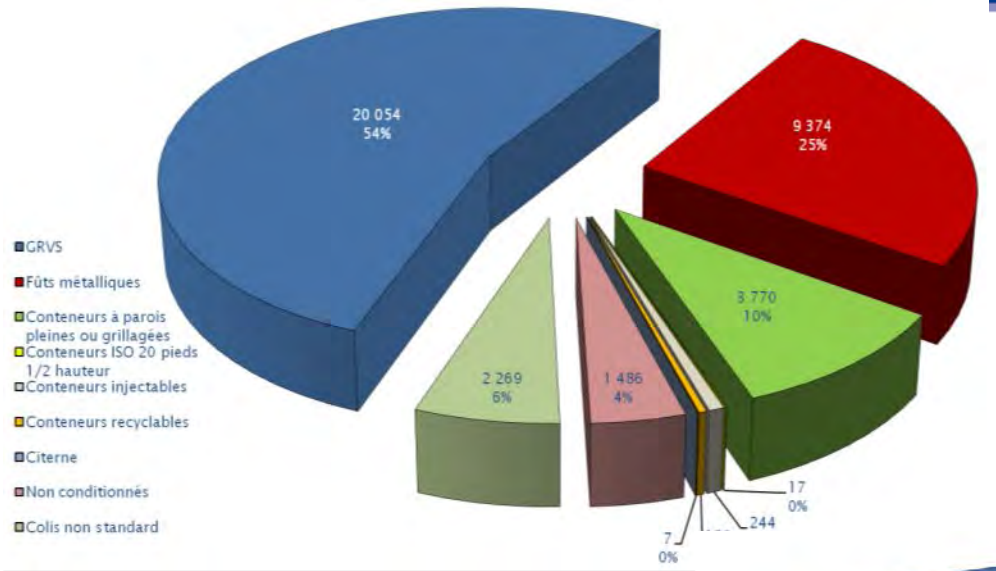
Radiological controls

Waste packages are identified

Waste packages are transferred onto the trailer of the Cires on-site truck

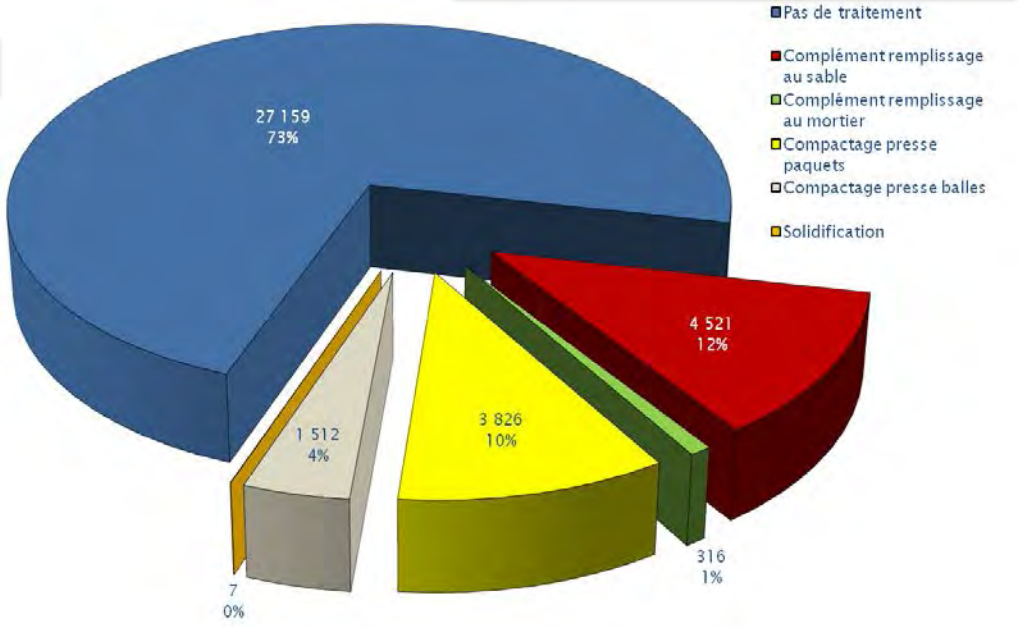
Waste packages are transferred to the disposal cell

2. Standard management of waste packages on the Cires



Distribution by type of waste packages

Distribution by type of treatment



3. Safety

3.1 Main objectives

Primary purpose of a disposal facility for VLLW

"To guarantee that people and environment are protected at short and long term"

Several elements play a part to achieve this goal :

- ✓ **Disposal design**
- ✓ **Characteristics of the site (geological formation)**
- ✓ **Limits given to the radiological activity**

3.1 Main objectives

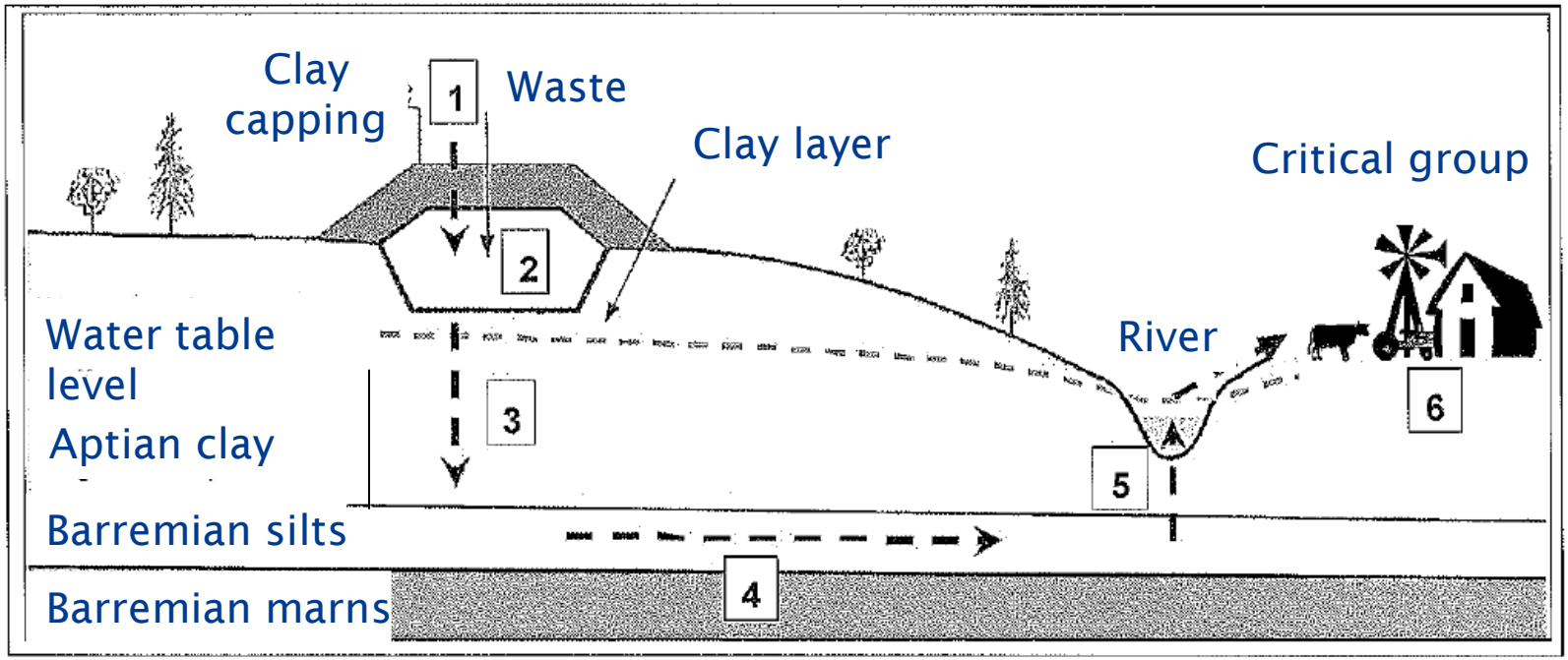
<u>Morvilliers Site selection criteria</u> ➔ presence of a clay layer with very good containment properties

The site of Morvilliers was chosen because of the presence of a clay layer which have containment properties better than those for non radioactive hazardous waste disposal.

<u>Requirements</u>	<u>Morvilliers site</u>
Permeability < 10^{-9} m/s	10 to 100 times less
Thickness > 5 m	15 to 25 m

3.1 Main objectives

- Radiological impact < 0,1 µSv/yr
- Insignificant chemical impact



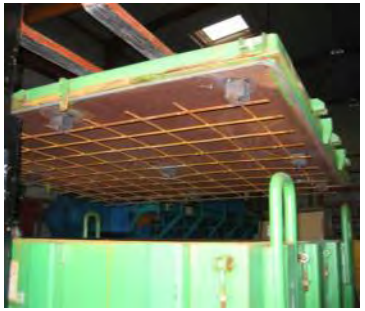
3. Safety

3.2 Safety in operation

3.2 Safety objectives in operation

Objective n°1 : prevent any risk of radioactive and\or toxic dispersal during the operations of the cell

- Waste presenting a risk of contamination dispersal must be delivered in closed packages

- Cleanliness of the containers of transport (absence of spots, diverse waste, water and limitation of the dust)
- Devices of wedging and stowage adapted (if complex: supply an explanatory plan)



3.2 Safety objectives in operation

Absence of waste dispersal - confinement

Asbestos package

Soils in metallic boxes

3.2 Safety objectives in operation

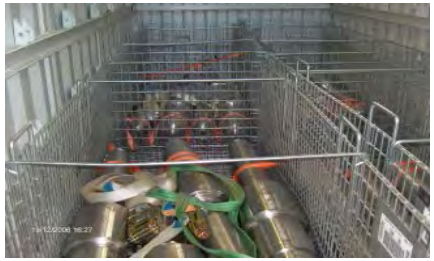
Objective n°2 : Contribute to the mechanical stability of the disposal cell on the long term, after implementation of the definitive cover

Waste packages directly disposed in the cell have to :

- insure the mechanical stability of the disposal cell (in operation and at long term)
- insure a mechanical resistance when trucks run on the waste packages

Waste packages must not :

- Contain important voids after being disposed
- Create a loss of disposal volume (disposal facility is limited to 650 000 m3)
- Create a significant consumption of material used for filling the voids



- The sand must be able to penetrate into the waste package (for package requiring a filling with sand)

3.2 Safety objectives in operation

Cell stability :

Arrangement of waste in the package

Voids have to be filled with sand or mortar

Voids between packages are filled with sand

3.2 Safety objectives in operation

Objective n°3 : allow the operation of disposal cells in safety conditions

- Mass of waste packages and tools used for the manutention have to be compatible with those used on the Cires


- The integrity of the waste packages must be guaranteed during its transport, its handling and the circulation of trucks on the massif of waste packages



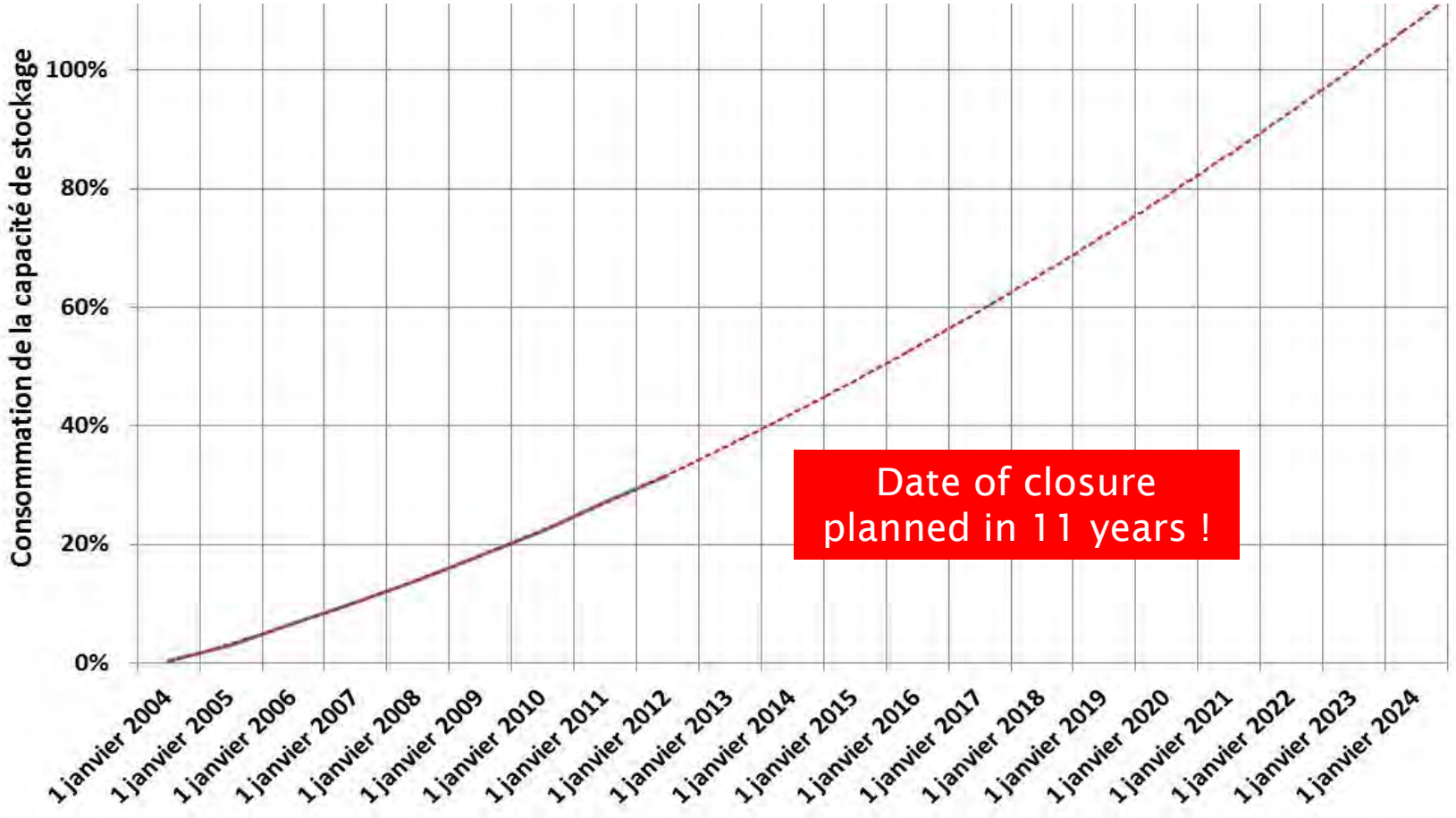

3.2 Safety objectives in operation

Disposal optimisation

Cell operation in safety conditions

3.2 Safety objectives in operation

Objective n°4 : Optimize the filling of the disposal cell and the whole associated supply chain (storing, unloading of the package, the return of the empty containers)



3. Safety

3.3 Long term safety : method

Why radiological activity is limited ?:

"To make the radiological consequences associated to every radionuclide transfer scenario acceptable"

Scenario ?:

- ✓ **usual and accidental situations**
- ✓ **considered as possible**
- ✓ **internal exposure risks (inhalation) or external exposure risks (radiation)**
- ✓ **scenario examples : at short term (putting in cell, truck knock over, fire) and at long term (roadwork, children play ground on the disposal cell).**

We make a distinction between 2 transfer ways:

- ✓ air (dust, gas, etc.)
- ✓ water (radionuclide contamination)

To respect all the safety criteria:

⇒ radiological activity limits by radionuclide:

- ✓ Air transfer : IRAS (Radiological Index of Acceptance)
  - ✂ For waste package
- ✓ Water transfer : radiological capacities
  - ✂ For disposal cells

3. Safety

3.4 Long term safety : transfer by air

For memory: IRAS is for **air transfer** and IRAS limits the waste **package** activities

Definition of IRAS:

✓ **IRAS define a dose constraint for each scenario = the exposure level considered as acceptable (workers, publics)**

$$IRAS = \sum_{i=1}^{n} \frac{Am_i}{10^{class_i}}$$

Am_i : specific activity RN i

$Class_i$: number of class for the RN i

3. Safety

3.5 Long term safety : transfer by water

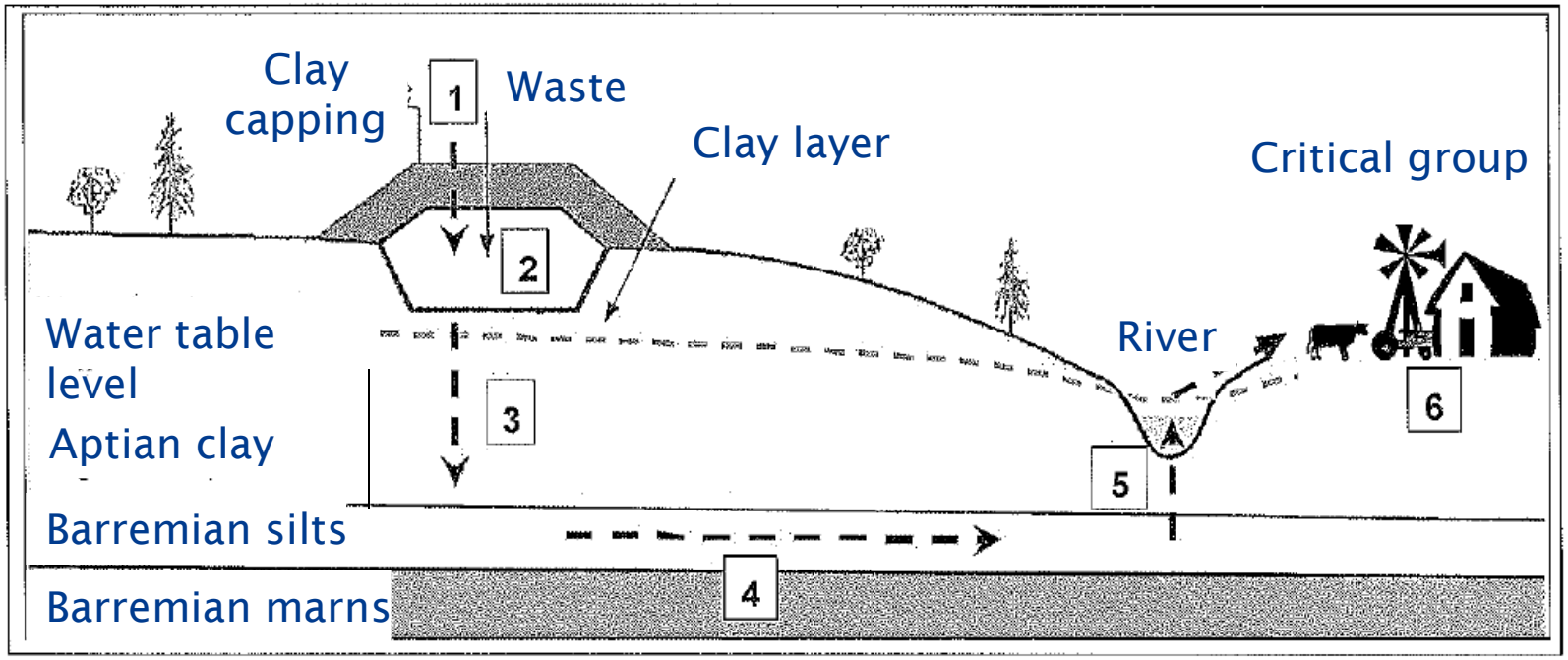
Radiological capacities :

For memory: radiological capacities are for **water transfer** and they limit the disposal cell activities

"We calculate the radiological impact for each scenario using total activity."

Forecast inventory (1,2 TBq of ^{239}Pu, 1,9 TBq of ^{14}C, etc.)

- Radiological impact < 0,1 µSv/yr



4. Waste Acceptance Criterias

4.1 Origin

4.1 Origin

Applicable specifications (= WAC) arise from :

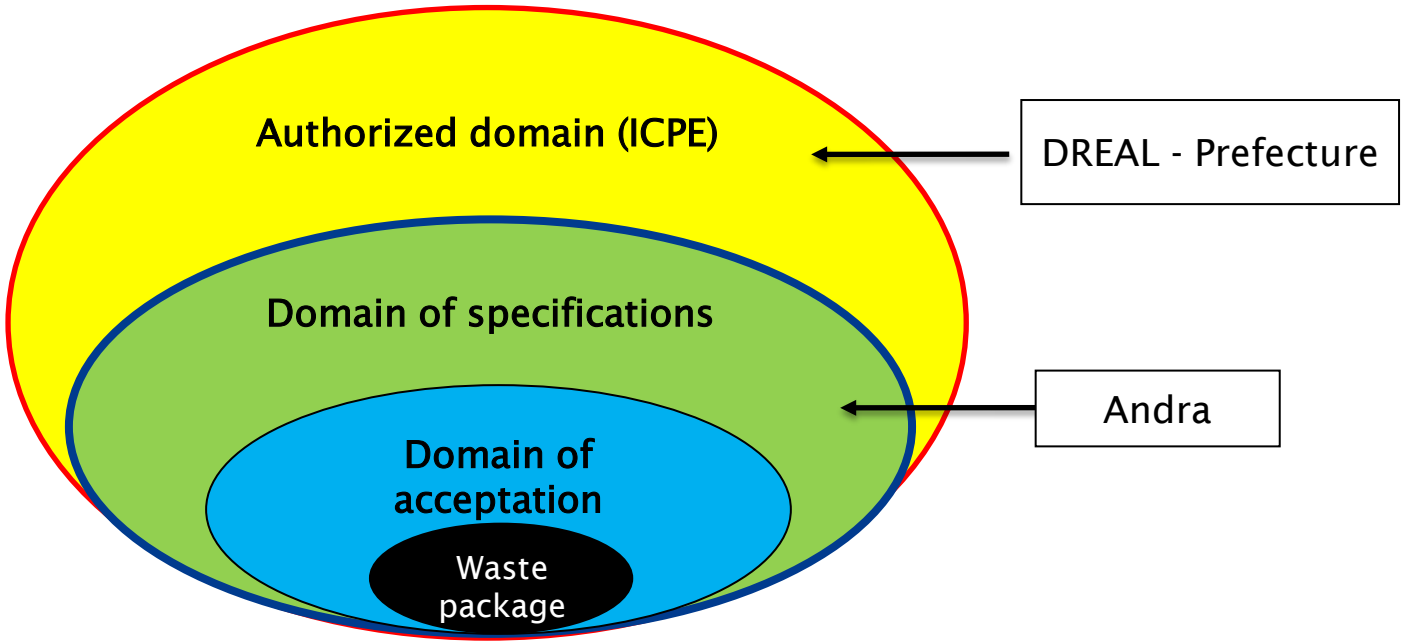
- regulatory framework
  - the file ICPE (Installation Classified for the protection of the Environment) asking for the authorization to exploit the disposal facility
  - the prefectural order allowing Andra to exploit the disposal facility
- general rules of operation (define the domain of operation)

All these documents define the domain of operation for the disposal facility. These documents distinguish the rules imposed by :

- the regulator (DREAL region Champagne – Ardennes)
- Andra (additionnal requirements)

4.1 Origin

Regional Department for Environment, Development and Accommodation



4.1 Origin

The prefectural order defines the following discharges :

Liquid discharges

No authorized liquid radioactive discharges

Gazeous discharges

Tritium : 30 GBq/yr
Carbon14 : 1 GBq/yr
Iodine : 2.10^{-3} GBq/yr
Alpha emitters : 2.10^{-5} GBq/yr
Beta emitters : 2.10^{-4} GBq/yr

4. Waste Acceptance Criteria

4.2 Applicable references

4.2 Applicable references
4.2.1 Applicable specification for the storage facility

This specification defines the applicable requirements for waste packages (no nuclear power plant waste) intended to be stored in the storage facility awaiting for a later expedition towards a final disposal facility.

This specification defines the applicable criteria in terms of physico-chemical, radiological characteristics and packaging, taking into account the design and the organization associated with the operation of the facility.

The applicable criteria in the storage facility do not take into account the constraints bound to the final disposal.

4.2 Applicable references
4.2.2 Applicable specification for the grouping facility

For the collection of radioactive waste coming from laboratories, hospitals, universities (non nuclear power plant waste), Andra has edited a guide of removal.

This guide of removal specifies the technical requirements due to the modes of treatment and storage of this waste.

This guide is downloadable on the site :

http://www.andra.fr/producteurs/pages/fr/menu44/vous-etes-un-hopital--une-universite--un-laboratoire-de-recherche-1652.html

4.2 Applicable references
4.2.3 Applicable specification for the disposal facility

The following specifications of acceptance are applicable to all the VLL waste packages :

- [Specification relative to the procedure of acceptance]
- General technical specification
- Specification relative to the physico-chemical criteria of acceptance
- Specification relative to the radiological criteria of acceptance
- Specification relative to the rules of packaging
- [Guide of declaration for the characteristics of waste packages]

4.2 Applicable references
4.2.3 Applicable specification for the disposal facility

The general technical specification define :

- The acceptable waste without limitation (not exhaustive list) :
  - Metallic waste,
  - Inert waste
  - Rubbles, glass
  - …
- The acceptable waste with limitation (not exhaustive list) :
  - Hazardous waste,
  - Sludges or soils chemically contamined
  - Asbestos (linked form)
  - Electronic waste
  - Fermentable
  - …
- The non acceptable waste (not exhaustive list) :
  - Waste : explosive, corrosive, easily flammable, infectious, putrescible, pyrophoric or strongly reactive
  - Containing occluded gaz
  - Asbestos (friable form)
  - Liquid (organic or aqueous)
  - Pulverulent waste not packaged beforehand
  - Hot > 60°C
  - War weapons
  - …

4.2 Applicable references
4.2.3 Applicable specification for the disposal facility

The physico-chemical specification defines the requirements for all the waste and focus on hazardous waste (ex : case of asbestos).

Linked asbestos :

- Only the linked asbestos is acceptable in the Cires disposal cells
- Not admitted for the treatment on the Cires (no compaction, no mortar injection)
- Realization of specific lots for which materials with asbestos must be identified
- It must be mentioned the quantity, the origin and the content of asbestos
- It must be indicated the cristallographic nature of asbestos when the information is available

2 different possibilities :

- Heterogeneous lots (amount of asbestos different between each waste packages) : individual declaration of asbestos content for each waste packages
- Homogenous lots : no individual declaration

No linked asbestos :

- Not acceptable in the disposal cells
- Acceptable if asbestos is treated (plasma torch)

No metallic waste :

- Average composition for all the lot
- Waste containing chemical toxic has to be identified (thresholds determined from those of the FMA) with quantification of the concentrations
- Quantification of the cellulosic waste: wood, cotton, paper
- Particular case: muds, concentrates, residues of incineration :
  - chemical analyses has to be supplied
  - Evaluation of the quantities in the waste of the following substances :
    - Inorganic: chloride, fluoride, nitrate, sulfate, carbonate
    - Organic : EDTA, NTA, DTPA, TTHA, oxalate, citrate, acetate, formiate, ascorbate, gluconate, sulfamate, phtalate…
    - Others: sulfonate
- Maximal value of solubility in water has to be below 10g / L (if > 10 g/L, a test has to be realized).

Case of others hazardous waste : acceptance criterias

- Waste can be accepted for the disposal it respects the following thresholds:
  - 4 < pH < 13
  - Global Fraction soluble < 10 % by mass of dry waste
  - Dryness > 30 %
  - On the fraction extracted in the lixiviate (mg/kg of dry waste) :
  - COT < 1000 mg/kg
  - Cr < 70 mg/kg
  - Pb < 50 mg/kg
  - Zn < 200 mg/kg
  - Cd < 5 mg/kg
  - Ni < 40 mg/kg
  - As < 25 mg/kg
  - Hg < 2 mg/kg
  - Ba < 300 mg/kg
  - Cu < 100 mg/kg
  - Mo < 30 mg/kg
  - Sb < 5 mg/kg
  - Se < 7 mg/kg
  - Fluorures < 500 mg/kg
- If the waste does not respect these thresholds, it has to be stabilized with a mortar

Case of others hazardous waste : characterization

- Raw waste chemical composition
- Spectre type : composition of the raw waste
- Content of complexing substances in the raw waste
- The results of a potential test of polluting intended to verify that the waste presents a reduced polluting character
- If the waste does not require a stabilization treatment, the results of a test of behavior of the waste according to the pH
- If the waste needs a treatment by stabilization, the results of a potential test of polluting realized on the stabilized waste
- If the waste is stabilized by the producer, Andra has to validate the process used

NB : It is possible to avoid carrying our the above tests if the necessary information for the characterization is known and duly justified

4.2 Applicable references
4.2.3 Applicable specification for the disposal facility

Identification and quantification when the content of a toxic chemical is superior to the following thresholds :

Toxic Chemical	Identification threshold (ppm mass)
Lead	100
Boron	20
Nickel	20
Total chromium	100
Chromium	10
Arsenic	10
Antimony	10
Selenium	10
Cadmium	10
Mercury	10
Beryllium	10
Cyanides	10

Case of complexing substances : requirements

- Evaluation of the quantities in the waste of the lot for the following substances :
  - Inorganic: chloride, fluoride, nitrate, sulfate, carbonate
  - Organic : EDTA, NTA, DTPA, TTHA, oxalate, citrate, acetate, formiate, ascorbate, gluconate, sulfamate, phtalate…
  - Others: sulfonate

Case of CMR (carcenogenic, mutagenic, reprotoxic) : requirements

- A particular declaration exists for waste containing CMR substances:
  - CMR nature
  - Category
  - Chemical form
  - Quantity (as possible) in the lot if the production is homogenous
- As long as the experience feedback is not sufficient, individual acceptance has to be given in order to determine the acceptability of waste packages containing CMR

4.2 Applicable references
4.2.3 Applicable specification for the disposal facility

The radiological specification defines :

- The radiological criteria of acceptance
- The conditions of radionuclide identification
- The conditions of evaluation and declaration of waste activity

In order to determine the acceptability of a waste batch or a waste package, a specific index has been defined (IRAS = Radiological Index for Disposal Acceptance)

$$IRAS = \sum_{i=1}^{n} \frac{Am_i}{10^{class_i}}$$

Am_i : specific activity RN i

$Class_i$: number of class for the RN i

Waste is acceptable for the disposal if :

- IRAS ≤ 1 : for a waste lot
- IRAS ≤ 10 : for a single package of a lot :

4.2 Applicable references
4.2.3 Applicable specification for the disposal facility

Index IRAS has for function to limit the specific activity of waste to be disposed

Objective : answer to the scenario of transfer by air for which the radiological impact is proportional to the waste specific activity

Methodology for the class determination :

- Definition of the scenarios allowing to estimate the radiological impact associated with transfer by air
- For each scenario : definition of exposure level considered as acceptable (constraint of dose)
- For each scenario: calculation of the specific activity of the RN leading to a radiological impact equal to the constraint of dose
- For each RN : the smallest acceptable specific activity for the set of the scenarios (maximal acceptable specific activity) was retained
- For each RN : we round this specific activity to 1Bq/g (class 0) or to 10 Bq/g (class 1), … Class i = 0, 1, 2, or 3

Class definition for VLLW :

- Class 0 : 10^{class} equal to 1 Bq/g
- Class 1 : 10^{class} equal to 10 Bq/g
- Class 2 : 10^{class} equal to 100 Bq/g
- Class 3 : 10^{class} equal to 1.000 Bq/g

CLASS VLL 0								
			^{250}Cm					
CLASS VLL 1 (extract)								
^{22}Na	^{54}Mn ^{134}Cs ^{137}Cs ^{227}Ac ^{241}Am	^{60}Co ^{133}Ba ^{228}Th	^{65}Zn ^{144}Pm ^{232}Th	^{94}Nb ^{152}Eu ^{231}Pa	^{108m}Ag ^{154}Eu ^{237}Np	^{110m}Ag ^{166m}Ho ^{238}Pu	^{126}Sn ^{226}Ra ^{239}Pu	^{125}Sb ^{228}Ra ^{240}Pu
CLASS VLL 2 (extract)								
^{40}K	^{57}Co ^{238}U	^{106}Ru	^{144}Ce	^{210}Pb	^{232}U	^{233}U	^{234}U	^{235}U
CLASS VLL 3 (extract)								
^{3}H	^{10}Be ^{87}Rb ^{135}Cs	^{14}C ^{90}Sr ^{151}Sm	^{36}Cl ^{93}Zr ^{155}Eu	^{41}Ca ^{93}Mo ^{204}Ti	^{55}Fe ^{99}Tc ^{241}Pu	^{59}Ni ^{107}Pd	^{63}Ni ^{121m}Sn	^{79}Se ^{129}I

Example for IRAS calculation

- Average specific activity for a lot of waste : 10 Bq/g

RN_i	Class	Spectre type	Specific activity (Bq/g)	$IRAS_i$
Co60	1	25 %		
Fe55	3	30 %		
Cs137	1	20 %		
Sr90	3	20 %		
Pu239	1	5 %		
Total		100 %	10	

Example for IRAS calculation

- Average activity for a lot of waste : 10 Bq/g
- IRAS : 0,505

RN_i	Class	Spectre type	Specific activity (Bq/g)	$IRAS_i$
Co60	1	25 %	2,5	0,25
Fe55	3	30 %	3	0,003
Cs137	1	20 %	2	0,2
Sr90	3	20 %	2	0,002
Pu239	1	5 %	0,5	0,05
Total		100 %	10	0,505

4.2 Applicable references
4.2.3 Applicable specification for the disposal facility

Radionuclide identification

All radionuclides having a period between 6 months and 5.10^{10} years and presenting a specific activity superior to its threshold of declaration must be declared. Radionuclides with a period inferior to 6 month have to be declared if they represent more than 10 % of the total activity of waste package.

Radionuclides with a natural origin don't have to be declared (ex : ^{40}K)

Activity evaluation

All the methods that allow to obtain the identification and the quantification of the present radionuclides in the waste must be performed using reliable techniques and a reasonably conservative estimation (based on the upper-bound approach of the activity evaluation)

- Dose rate + transfer function
- Measures (indirect) of the surface contamination
- Gamma spectrometry
- Alpha spectrometry
- Liquid scintillation (^{3}H)
- …

4.2 Applicable references
4.2.3 Applicable specification for the disposal facility

Ex :

Radionuclides	Period (years)	Class	Declaration treshold (Bq/g)	Limit of flat rate declaration (Bq/g)
H3	1,23E+01	3	1	10
Be10	1,60E+06	3	0,01	1
C14	5,73E+03	3	0,1	1
Na22	2,60E+00	1	0,1	
Al26	7,20E+05	1	0,1	
Si32	1,72E+02	3	10	
Cl36	3,02E+05	3	0,01	0,1
Ar39	2,69E+02	3	10	
Ar42	3,30E+01	3	10	
K40	1,28E+09	2	1	
Ca41	1,03E+05	3	0,01	0,1
Ti44	4,72E+01	1	0,1	
V49	9,03E-01	3	10	
Mn53	3,70E+06	3	10	
Mn54	8,56E-01	1	0,1	
Fe55	2,70E+00	3	10	
Fe60	7,51E+06	3	10	
Co57	7,43E-01	2	1	
Co60	5,27E+00	1	0,1	
Ni59	7,49E+04	3	10	100
Ni63	1,00E+02	3	10	
Zn65	6,69E-01	1	0,1	
Ge68	7,42E-01	1	0,1	
Se79	6,50E+04	3	0,01	0,1

Particular case : attribution of a flat rate activity

All the waste packages will have the same specific activity

It is a tolerance given in order to not to have to use significant resources to estimate the activity if it does not require it.

It is essential that the evaluation of the activity has a guaranteed conservative margin (i.e. upper bound nature of the activity evaluation)

Necessary conditions :

- Specific activity < limit of flat rate declaration (LDF)
- Waste package IRAS < 0,5
- Upper bound nature of the specific activity evaluation

Ex : wall demolition

- Specific activity measured in the “hottest” point will be applied to all the waste

4.2 Applicable references
4.2.3 Applicable specification for the disposal facility

Particular case : Uranium

- Specific activity of each waste package containing uranium should not exceed 100 Bq/g
- For the uranium enriched beyond 1 % :
  - Fissile materials content < 0,1 g/L of waste
  - Mass ^{235}U by waste package < 50 g

Particular case : Tritium

- Waste package requiring a treatment (compaction / stabilization) must be :
  - Particularly declared if the activity of ^{3}H is superior to 0,3 GBq
  - Particularly planned for delivery if the activity is superior to 3 Gq

Particular case : Carbon 14

- Waste package requiring a treatment (compaction / stabilization) must be :
  - Particularly declared if the activity of ^{14}C is superior to 0,01 GBq
  - Particularly planned for delivery if the activity is superior to 1 Gq

Particular case : radium waste

- Particular acceptation for waste package containing ^{226}Ra if :
  - Specific activity of ^{226}Ra is superior to 10 Bq/g
  - They need treatment (compaction / stabilization), whatever their specific activity

4.2 Applicable references
4.2.3 Applicable specification for the disposal facility

Nuclear materials

- Mass limited at 80 g / by expedition for ^{235}U enriched up to 20 %
- Mass limited at 15 g / by expedition for ^{235}U enriched at more than 20 %

Dose rate

- If the dose rate in contact of the waste package is upper to 80 µSv/h :
  - Check if the waste package is eligible for the VLL waste disposal
  - Inform Andra

Surface contamination

- Surface contamination is limited to 4 Bq/cm² (βγ) and 0,4 Bq/cm² (α) (and if possible < 0,4 Bq/cm² (βγ) and 0,04 Bq/cm² (α))
- External and internal cleanliness of containers used for transportation

4.2 Applicable references
4.2.3 Applicable specification for the disposal facility

The specification relative to the rules of packaging defines :

- the main principles of packaging
- different rules specific to the various types of package

Packages have to guarantee the safety in operation and at long term of the disposal :

- Objective n°1 : prevent risks of radioactive and/or chemical dispersion during operation, handling, treatment and disposal
- Objective n°2 : contribute to the mechanical stability of the cells on the long term after implementation of the definitive cover
- Objective n°3 : allow the operation of cells in satisfactory conditions of safety
- Objective n°4 : optimize the filling of cells and all the associated supply chain

Rules of packaging : ex linked asbestos

	Metallic box with full walls (filled with sand by the producer)	Metallic Box with full or wired walls)	Large component without packaging
Waste containing accessible asbestos	Ok		
Waste containing inaccessible asbestos	Ok	Ok	Ok

Recommendations :

- Tag « asbestos »
- Accessible asbestos :
  - Waste placed in vinyl
  - Full and free sheet of steel on the sand used for the filling of waste package