Low- and Intermediate-Level Waste Packages Quality Control Inspections

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The approval and acceptance system

Andra

- Defines technical specifications acceptance procedure
- Conducts review of the proposal Delivers an agreement
- Performs monitoring of waste packages quality audits controls

Waste producers *EDF, CEA, AREVA, etc.*

- Generate proposal for waste treatment, conditioning and transport
- Produce waste packages
- Deliver waste packages

Safety authority

- Control and follow-up of the process

Andra manages all waste, but the waste remains the permanent property of producers

Monitoring applied to LLW/ILW packages

Four types of inspection are performed on the packages:

① Verification of declared characteristics: computer checks of 100% of the package declarations made by the producer (before shipping);

② Inspections on arrival at the CSA: compliance of transport, dosimetry, surface contamination and visual examination of packages;

③ Visits to producers (process audit, inspection of operations, participation in producers' internal monitoring): regular checks to make sure that the waste packages are made up and characterised in accordance with the measures set out in the producer file used by Andra to give its acceptance;

④ Destructive and non-destructive inspections: to check the quality of the waste packages and the consistency between results and declared properties.

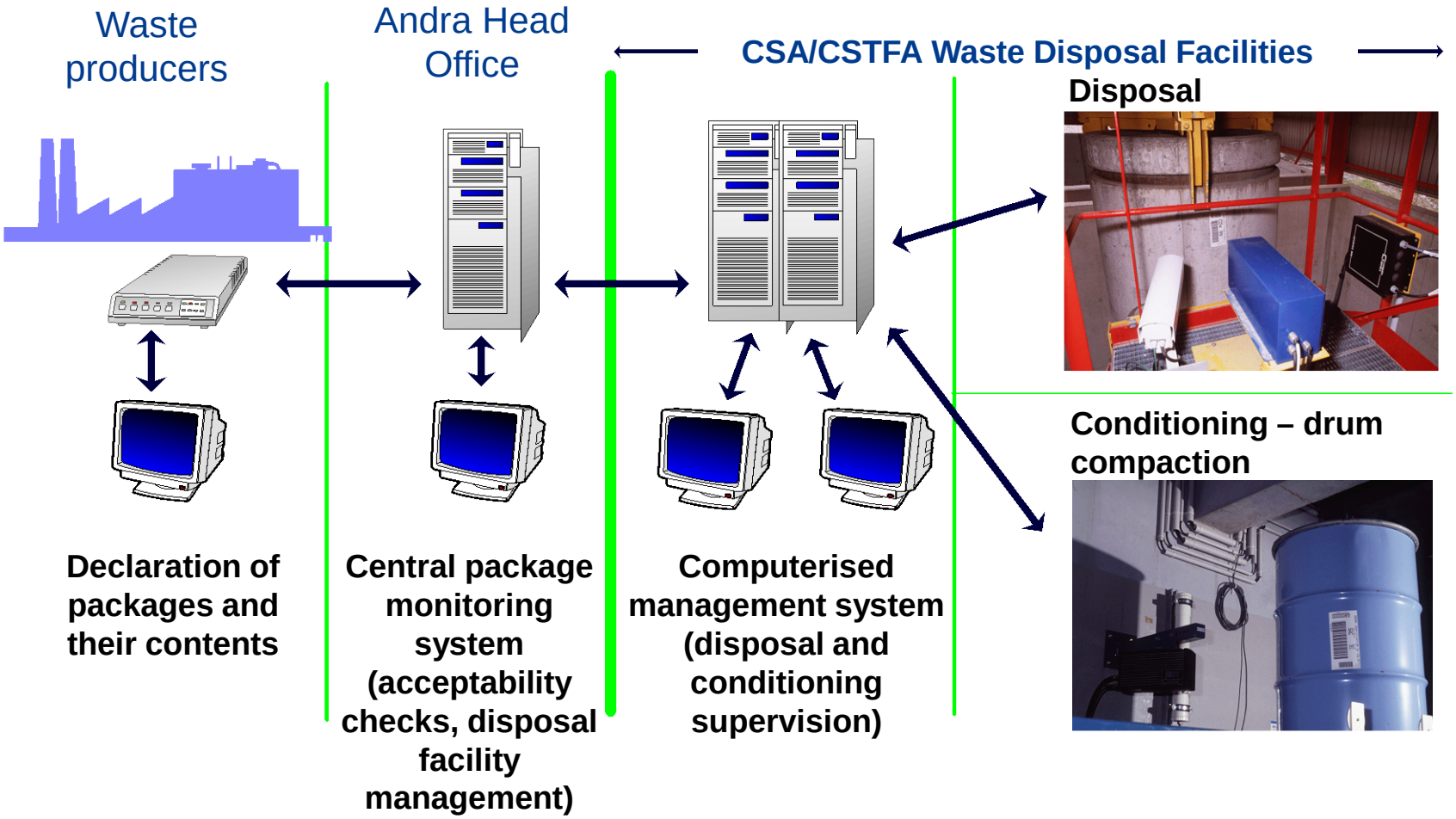
Monitoring applied to LLW/ILW packages

① **Verification of declared properties:**

Objective : to trace the history and contents of each package from manufacture by the producer to its emplacement at the disposal facility

- A barcode unique to each package
- A database: PROCOM
  - Exchange of information between producers and Andra;
  - Verification that certain properties of the packages comply with both approvals and specifications;
  - Inventory management.

Monitoring applied to LLW/ILW packages



Monitoring applied to LLW/ILW packages

Check that declarations are consistent with approvals

By using reference files

Check the acceptability of the packages

Calculate the activity by nuclide

Compare with specified limits

Store the information received

Monitoring applied to LLW/ILW packages

On completion of monitoring or after arrival at CSA a deviation may be reported:

① With respect to the approval baseline ⇨ derogation with approval

②With respect to the specification baseline ⇨ derogation with specifications

③With respect to the authorised area ⇨ ASN derogation

In the event of a deviation or a non-compliance in a package, a REPORT is always prepared. This report should lead to:

① An investigation of the causes to identify the actions required to avoid a second report.

② The implementation of appropriate measures if none exist.

③ Agreement with Andra on measures to be implemented to avoid any recurrence of the deviation.

Note: corrective action on the package does not eliminate the need to implement appropriate measures.

Fortunately…

most of the packages have no defects

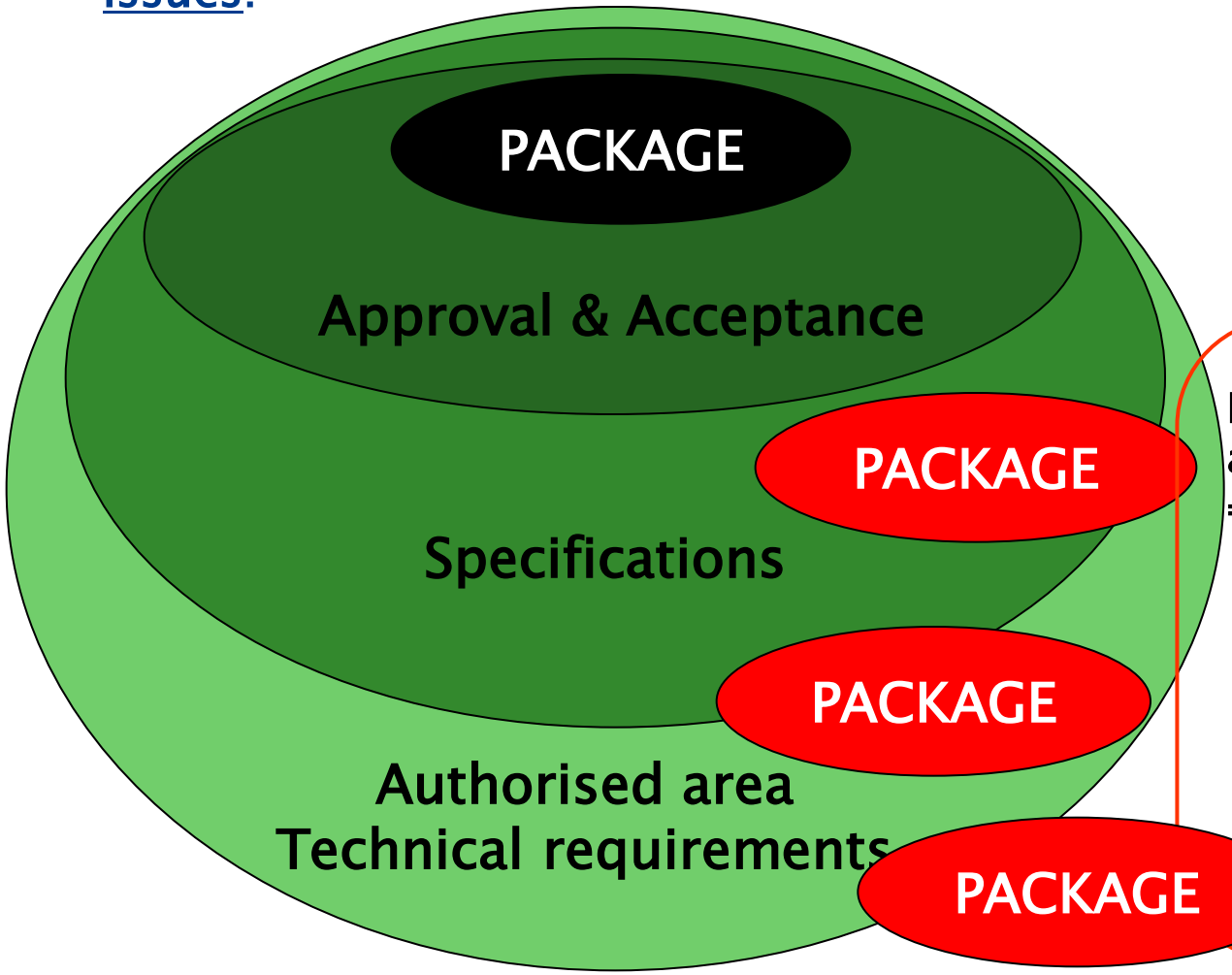
Discrepancies occur often on the first packages of a new type being produced

discrepancies are often due to a lack of training of the staff at the producers' sites

Producers respond rapidly in order to re-start acceptation and deliveries to the disposal facility

Monitoring applied to LLW/ILW packages

Issues:



Package complies with expectations
=>> Accepted for disposal!

Package not compliant with approval
=>> Derogation with approval

Package not compliant with specifications
=>> Derogation with specifications

REPORT

Non-compliant package
=>> ASN authorization

LLW and ILW packages quality-control inspections : Destructive and non destructive test

Principles of inspections

- Achievable on any Radwaste package (according to the available means of quality-control inspections), according to the projected quality-control program
- On one part, taking Radwaste packages for inspection randomly
- On the other part, taking into account :
- Experience feedback (previous quality-control inspections, upstream monitoring remarks…)
- Informations of the Industrial Direction such as :
  - New Radwaste package acceptance
  - Suspension of shipments decided
  - Implementation of corrective actions
  - Andra nuclear facilities abnormal events
  - Specific dispensation, specific Radwaste package acceptance

LLW and ILW packages quality-control inspections : Destructive and non destructive tests

LLW and ILW packages quality-control strategy

- Performed on already delivered industrial packages at the disposal facility: ultimate step of surveillance

- Performed by a dedicated unit within Andra (independent from acceptance unit): an upstream « critical » review for waste package acceptances

CSA ~25 000 packages per year

Number of performed non destructive tests: 200 per year
3 700 packages over 20 years

Number of performed destructive tests: 15-20 per year
280 packages over 20 years

LLW and ILW packages quality-control inspections : Destructive and non destructive tests

LLW and ILW packages quality-control strategy

3 years planned quality-control inspections :

- To sample and control the different waste packages received at CSA with a 3 years period (focused on ILW packages, approximately 34% of the tested waste packages)
- New packages accepted are systematically tested !
- Also based on quality-control experience feedback…

➲ To check the consistency between results and declared properties (e.g. short and long lived radionuclides to be considered), for « measurable parameters »

➲ To ensure of the compliance of interest parameters to the specifications : embedding treshold, acceptance limits, quantity of fissile materials…

➲ To acquire knowledge (e.g. long lived radionuclides ratios used by producers)

➲ *Non destructive testings are preferred*

LLW and ILW packages quality-control inspections : Destructive and non destructive tests

Definition of the various quality-control inspections on radioactive waste package delivered at CSA

1-Initial non destructive testings

- Visual examinations, radiological measurements

2-Complementary non destructive testings

- Mainly gamma spectrometry but also alpha measurements (neutronic active and passive measurements, photofission measurements)

3-Destructive testings

- Inventories, core drillings and cuttings of radioactive waste packages
- To provide samples for radiochemical analysis and technical assays

Needs of :

- Specialized and dedicated nuclear facilities, equipments and very sensitive and reliable measurement instrumentations
- High technical skills for quality-control inspections (expertise)

LLW and ILW packages quality-control inspections : Destructive and non destructive tests

Metal drums for compaction

Grouted metal drums

Non grouted metal container (5 m³, 10 m³)

Concrete hulls

Cubic concrete container

Ingots

External facilities and laboratories

Andra

Non Destructive Testings (NDT) at CSA

NDT

Destructive Testings (DT)

Technical assays

Radiological and chemical analysis

LLW and ILW packages quality-control inspections : Destructive and non destructive tests



Non destructive tests (1)



Radioactive waste package = Container (+ Embedding matrix) + Radioactive waste

➔ **Non destructive testings on radioactive waste packages delivered at CSA**

- Physical features: mass, dimensions
- Visual examinations (holes, cracks…)
- Radiological controls : surface contamination, dose rate and gamma spectrometry measurements

▪ More than 200 waste packages per year

Complementary non destructive and destructive tests made by CEA and other facilities (laboratories…)

Gamma spectrometry measurements on radioactive drums at CSA

LLW and ILW packages quality-control inspections : Destructive and non destructive tests

Non Destructive Tests (2)

Neutron measurements

Alpha measurements :

- Gamma spectrometry (isotopic content)
- Passive and Active Neutron measurements ,
- Active Photofission Measurements and Tomography

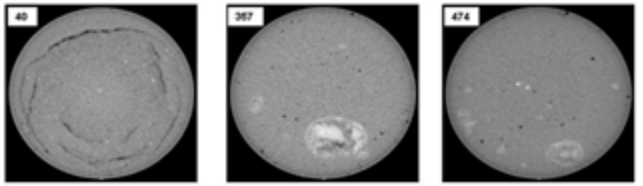
Photofission at Saphir facility (CEA-Saclay)

➥ Quantification of the actinide mass : actinide differentiation, isotopic content of U and Pu, fissile mass, Alpha activity …

Low energy X-Radiography (drums for compaction)

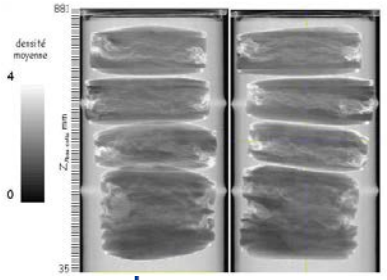
Imaging methods :

- Low energy X-Radiography (drums for compaction)
- High energy X-Radiography (concrete hulls)
- Active Gamma Radiography and Tomography (grouted drums)



Gamma tomography on homogeneous waste in grouted drums

- To detect prohibited waste (e.g. liquids), unfilled spaces (void rate)
- To ensure good confinement properties (waste positioning, grouted envelope thickness)
- To gain knowledge on waste (physical properties…)



Gamma radiography on heterogeneous waste in grouted drums

LLW and ILW packages quality-control inspections : Destructive and non destructive tests

- Waste inventory
- Collection of samples
- Reconditioning in drums for gamma-spectrometry purposes and/or Neutron measurements

- Coring: homogeneous waste, container, overpack
- Cutting: homogeneous and heterogeneous waste
- Collection of samples
- Gamma spectrometry on bare waste or reconditioned waste in drums

LLW and ILW packages quality-control inspections : Destructive and non destructive tests

Destructive Tests (1)

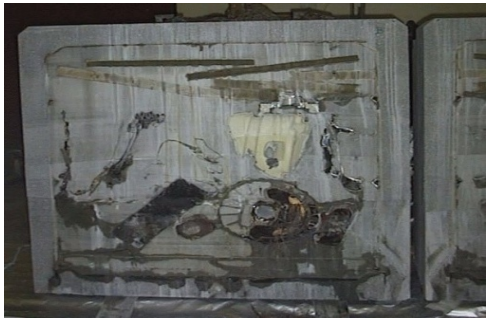
- Inventories of waste packages (drums for compaction, non grouted metal containers 5 and 10 m^3) :
  - To examinate the waste and their consistency with the declared physical properties (materials, prohibited waste, restricted waste, massive pieces, metal shields)
  - To ensure the absence of waste in the internal confinement area (for the grouted envelop), the absence of corrosion …
  - To provide samples for technical assays and analysis
  - Re-packaged waste (similar materials) for gamma spectrometry and neutron measurements

Destructive testing : prohibited waste discovered in a 200 liters metal drum for compaction (asbestos)

LLW and ILW packages quality-control inspections : Destructive and non destructive tests

Destructive Tests (2)






Cuttings and core drillings :

Grouted metal drums, concrete hulls and cubic concrete containers

↳ Cuttings in homogeneous and heterogeneous waste packages

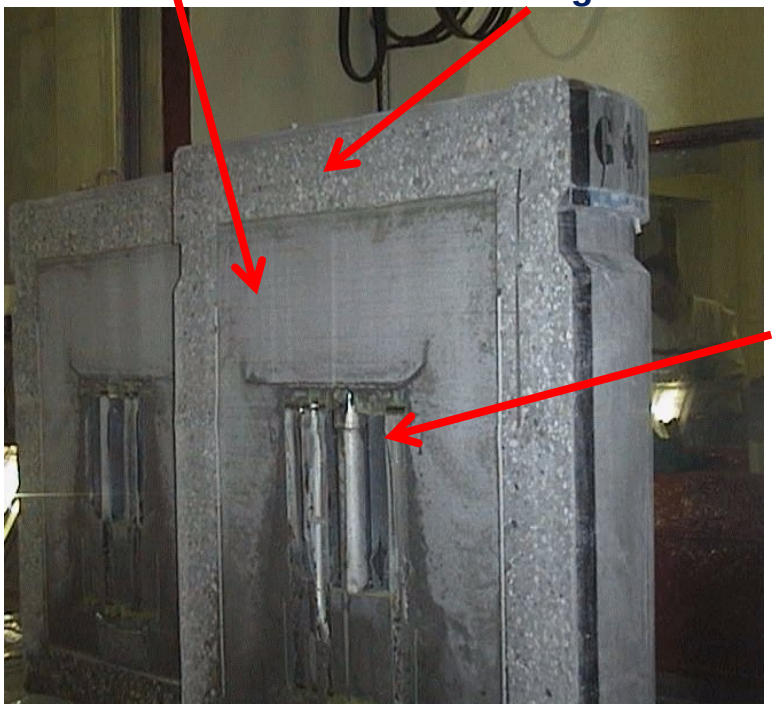
- To ensure :
  - homogeneity of the waste
  - internal structure of the package (positioning of waste, void, crack …)
- To measure the thickness of the grouted envelop
- To provide samples for technical assays and analysis

↳ Core drillings in homogeneous waste packages in container and confinement grouted envelop used for heterogeneous waste

- To ensure homogeneity of the waste
- To provide samples for technical assays and analysis

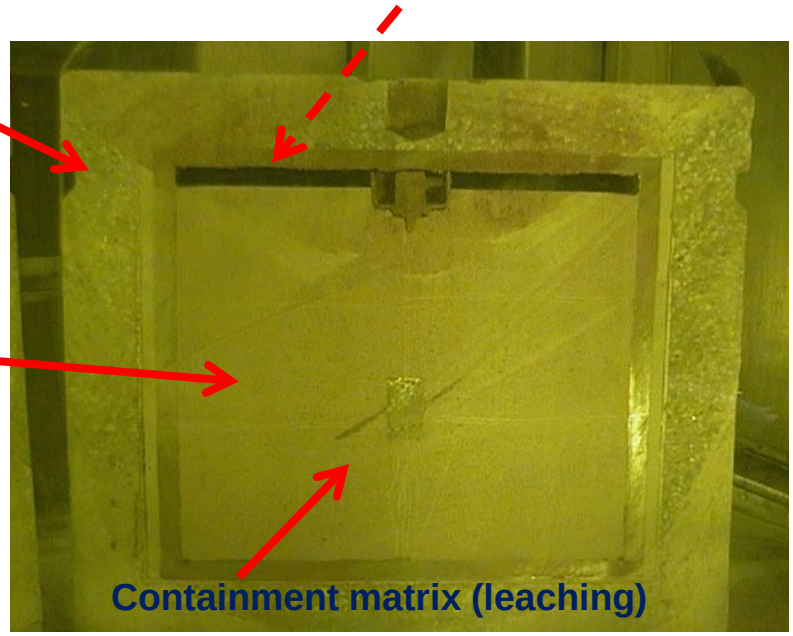
LLW and ILW packages quality-control inspections : Destructive and non destructive tests

Example of destructive inspections compared to the waste acceptance criteria



Water filter waste packages

(intermediate level short lived package)



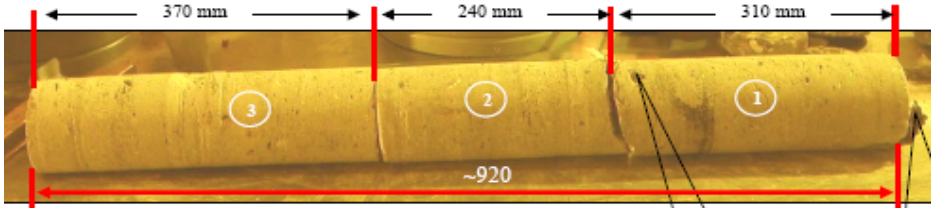
Spent resins waste packages

(intermediate level short lived package)

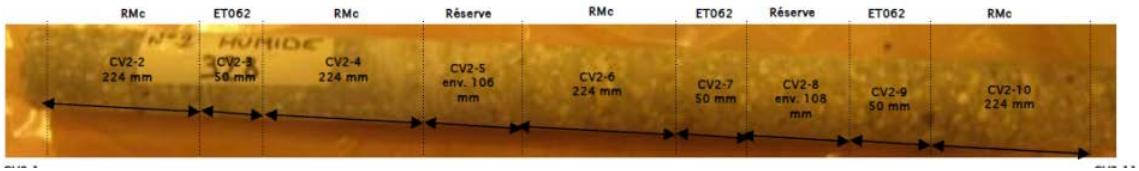
LLW and ILW packages quality-control inspections : Destructive and non destructive tests

Technical assays

Technical assays on container, on grouted envelop, on embedding matrix



Core drill pieces



- **Mechanical strength**
- **Water porosity, density**
- **Gaz permeability**
- **Diffusion coefficient (tritium)**
- **Leaching rate (on samples, seldom on waste package)**
- **Tritium and ^{14}C release (on waste packages, on representative samples)**

LLW and ILW packages quality-control inspections : Destructive and non destructive tests

Radiological and chemical analysis (1)

- Sampling plan (homogeneous waste)

  - Representative samples are to be taken so that :

    - ➔ they can be radiologically and chemically tested to characterize the radiological and chemical content of the waste block
    - ➔ in compliance with the laboratories acceptance criteria (radiological content)

  - Visual examinations, dose rate and gamma-scanning measurements (during destrutive assays)
  - Collecting a significant number of powder samples by a mechanical dry « µ-drilling » process, making gamma spectrometry measurements on these solid samples (radiological homogeneity)
  - Analysis of the measurements results with a (geo)statistical approach to characterize the hole waste block

- Digestion process to solubilize the collected homogeneous solis samples

LLW and ILW packages quality-control inspections : Destructive and non destructive tests

Radiological and chemical analysis (2)

- Gamma spectrometry (solid and liquid samples) : « easy to measure » radionuclides
- « Difficult to measure » short and long lived radionuclides analysis (chemical separation on solulized solid samples are often necessary)
  - Bêta measurements
    - Gamma spectrometry
    - X spectrometry
    - Liquid scintillation counting
    - ICP-MS
  - Alpha measurements
    - ^{241}Am, U and Pu isotopic content : alpha spectrometry
    - U and Pu isotopic content : mass spectrometry
- Some of these radionuclides are “very difficult to measure”: Accelerator Mass Spectrometry (e.g. ^{10}Be, ^{36}Cl, ^{41}Ca ; ^{129}I) can be implemented

- Moreover :
  - Chemical analysis to quantify U, Pb, Hg, Sb, Cd, Se, As, Ni, Cr (Cr VI), B, Be by atomic absorption spectrophotometry, ICP-MS or ICP-AES
  - TOC (total organic carbon) on solid and liquid samples

LLW and ILW packages quality-control inspections : Destructive and non destructive tests

Conclusions (1) : Quality-control Radwaste packages inspections ⇨ Report, Experience feedback

- Checking :
  - The compliance of the Radwaste characteristics with the Andra specifications
  - The consistency between Andra measurements results and producer declared properties
- To acquire « over the years » knowledge on the Radwaste package

➲ Quality Management System : written synthesis technical papers and Word templates are referenced (electronic management of reference documents in a dedicated database). They can be easily consulted and modified

➲ Treatment of these results by a specific diagnosis committee can lead to the implementation of actions in the producer facility (process…) by Andra Industrial Direction and ensure the information traceability

Points of attention :

- Andra Radwaste packages quality-control inspections cannot substitute to the producter Radwaste packages own characterization !
- Cooperative discussions with the producer are necessary (e.g. Radwaste packages quality meetings)

LLW and ILW packages quality-control inspections : Destructive and non destructive tests

Conclusions (2) : Contributions of Radwaste packages quality-control inspections

- Linked with the upstream monitoring (complementary with previous collected data)
- This “last barrier supervision” is a strong element to allow Andra to evaluate the Radwaste packages quality mastery process of the producer
- Lead to improvement of :
  - the manufacturing process (e.g. good practices, embedding materials…), the methodology for quantifying the radionuclide activity (e.g for its accuraccy)
  - Quality-control inspections results considered in upstream « critical » review for waste package acceptance examination and dispensation (organization of dedicated committee considering feedback experience analysis)

- Final objectives : guarantee of the waste disposal safety, maintain of the public confidence, assesment and improvement of producer Radwaste packages quality mastery