



Soil Radiological Characterization and Remediation at CIEMAT

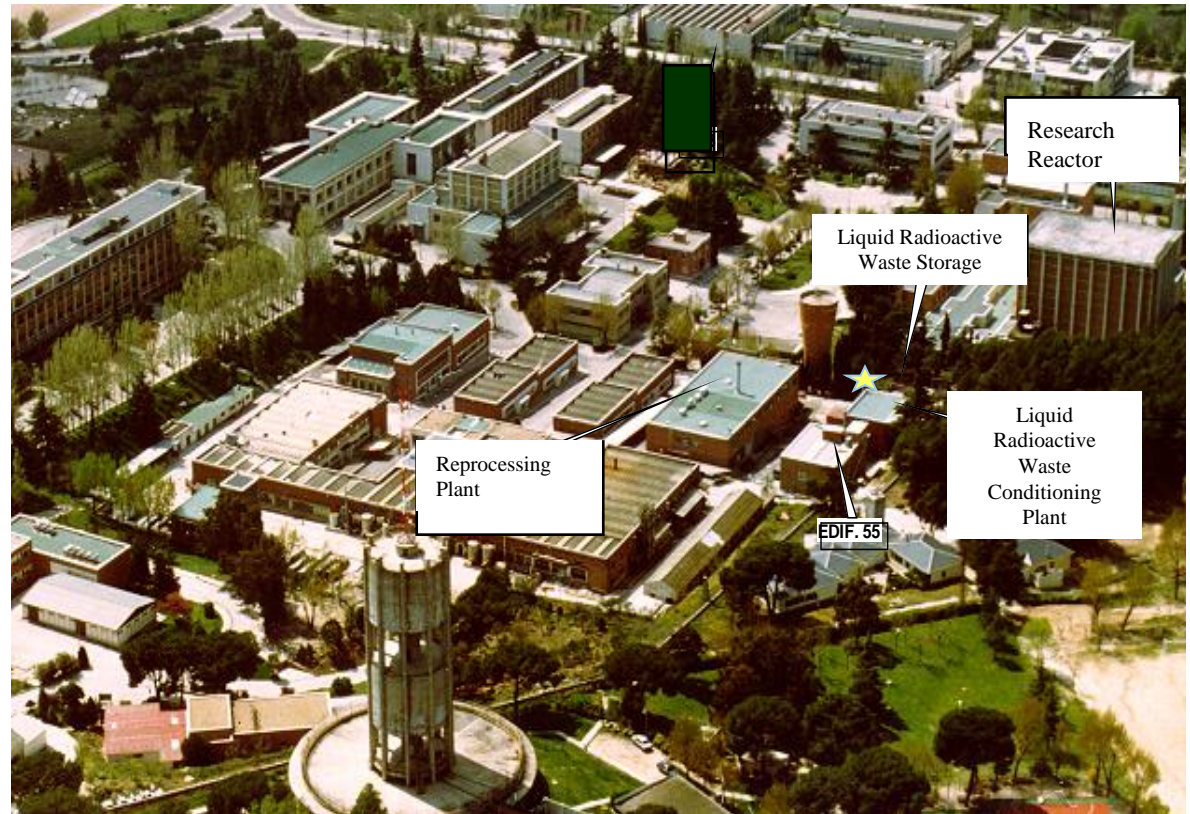
Workshop on "Radiological characterisation for decommissioning", Studsvik, Sweden 17-19 April 2012

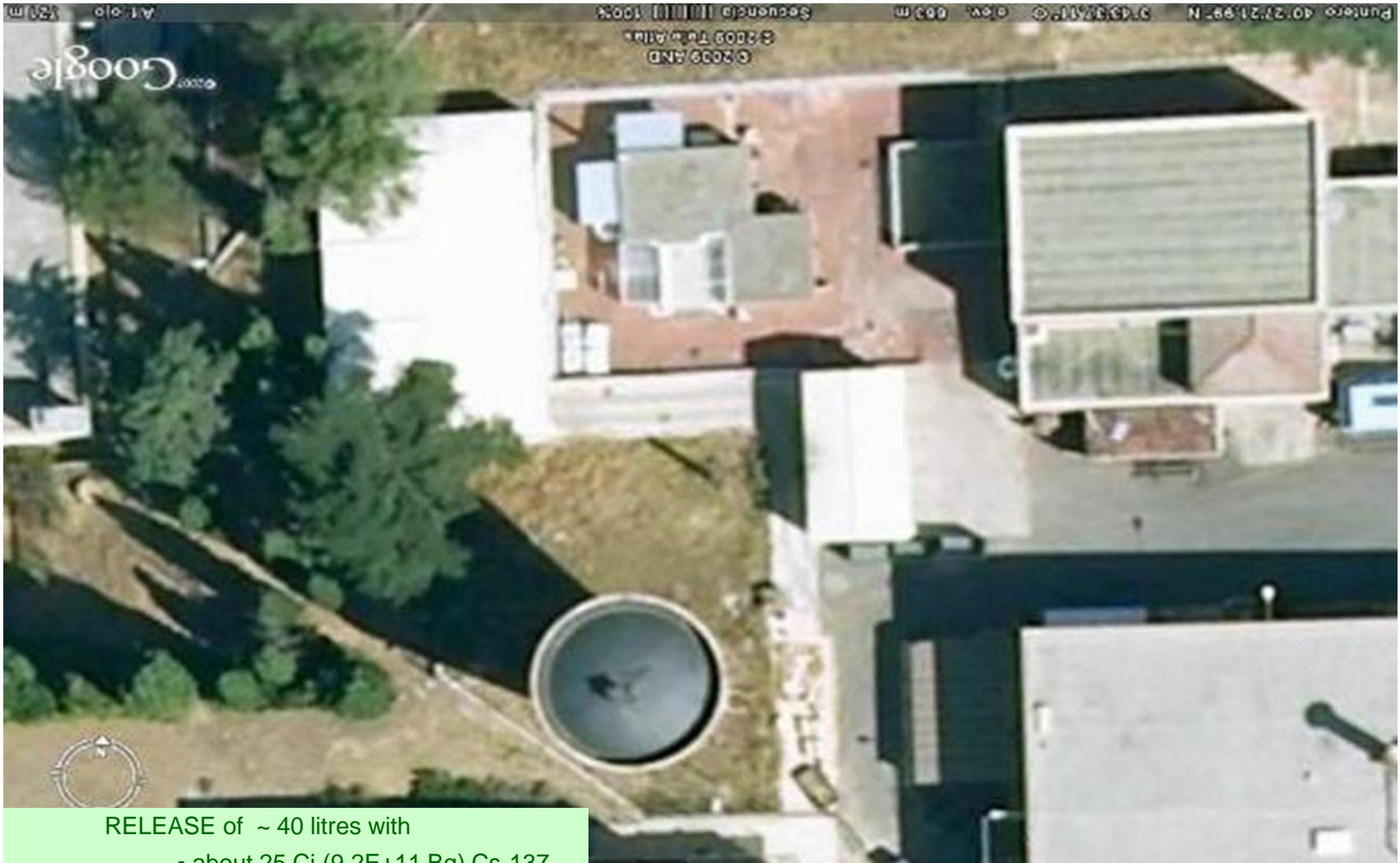
Cristina Correa, Esther García Tapias, José Luis Leganés
ENRESA, (Spain)

- 1. Introduction. PIMIC Decommissioning Project Overview and Lenteja incident.**
- 2. Initial radiological characterisation.**
- 3. Execution works and Radiological criteria**
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- 5. Final radiological survey.**
- 6. Conclusions.**

CIEMAT Spanish Centre for Energy related, Environmental and Technological Research

- * Research Reactor
- * Pilot Reprocessing Plant
- * Conditioning and Storage Plant for Liquid Waste
- * ENRESA started Dismantling works in 2006 and were finished in 2010.
- * Soil Restoration Activities (2010-2012)
 - * “Lenteja”





RELEASE of ~ 40 litres with

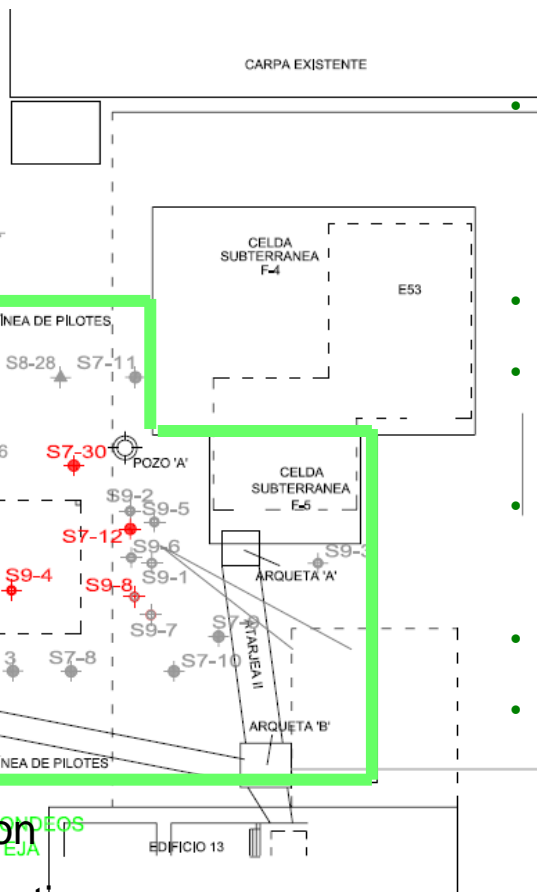
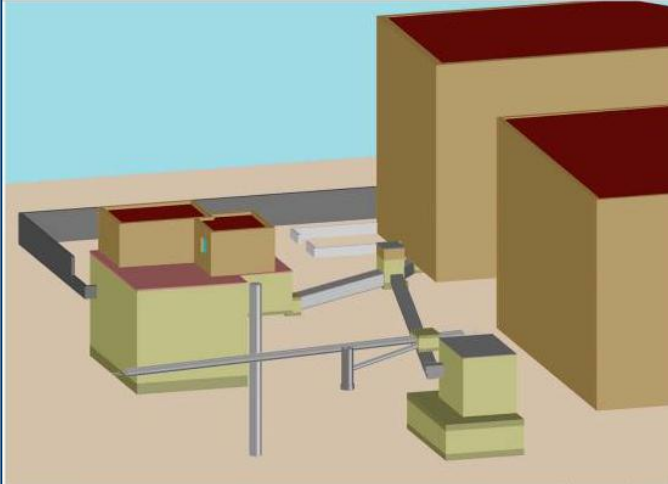
- about 25 Ci ($9,2E+11$ Bq) Cs-137
- about 30 Ci ($1,1E+12$ Bq) Sr-90

Introduction: Leakage incident.

- Soil was contaminated as a result of a pipe leakage, in the 70's
- At that time, part of the soil was removed, filled the holes with clean soil and covered with a concrete slab.
- Some activity remained in the ground.
- In 2010 Enresa started the execution of remediation activities.
- On March 2012 the excavated zone has been refilled



Initial radiological characterization



Three different boreholing surveys were performed (S7, S8, S9; 2004 - 2006).

- N° of samples: 277
- Main Radionuclides: Sr-90 & Cs-137, Alpha traces
- Range: From “0” up to 10^4 Bq.g-1 of Cs-137 & Sr-90
- Soil Volume estimate: 3,000 m³
- The affected area estimated was of 450 m² & up to 8 m deep.

Depth of contamination

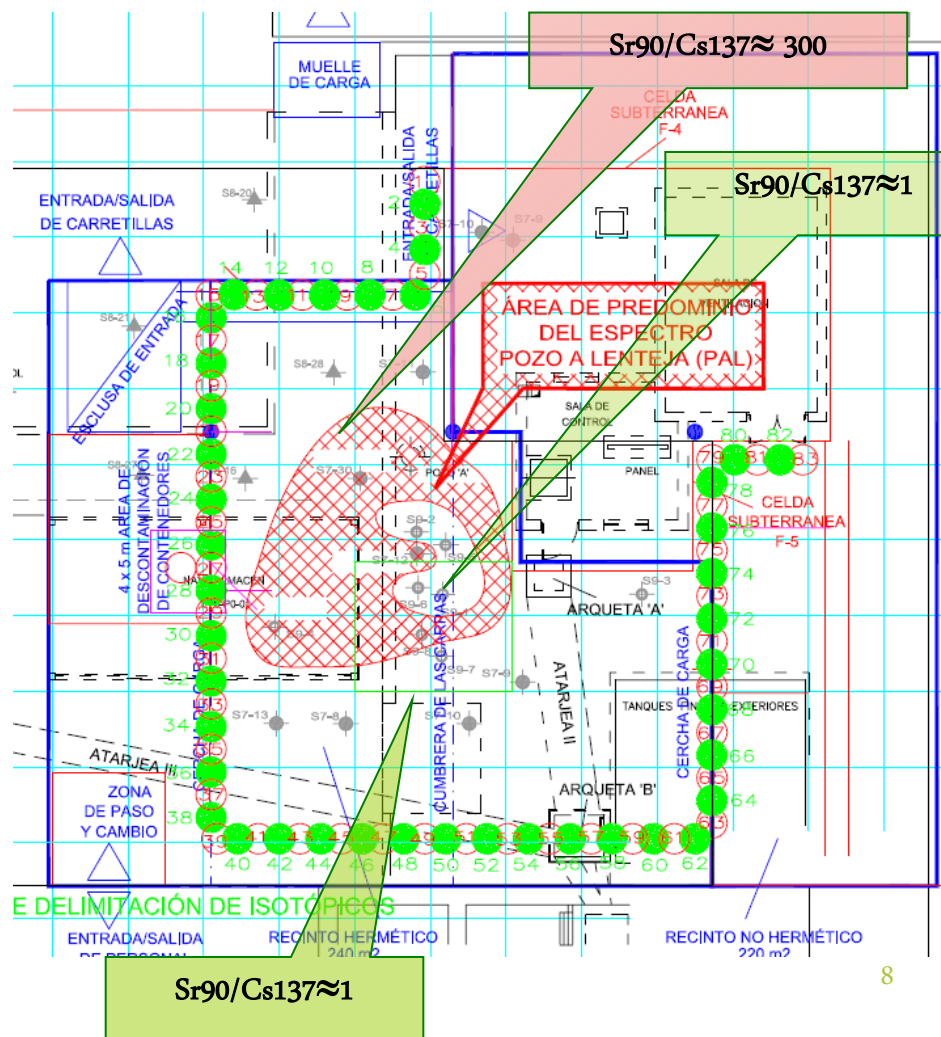
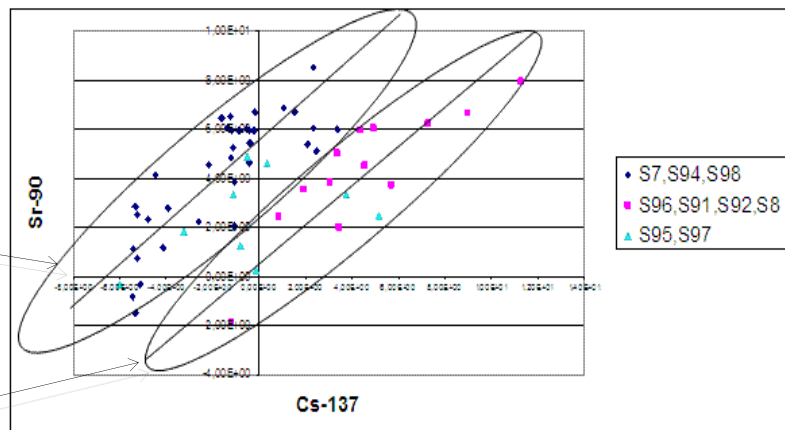
- 1-2 m deep: most of contamination
- 5 m deep: significantly decreased
- 9 m: less than 1 Bq/g

LÍNEA DE CONTAMINACIÓN PROFUNDOS DE LA ZONA DE LA LENTEJA
Febrero 2010

Initial radiological characterization: Distribution of contaminants

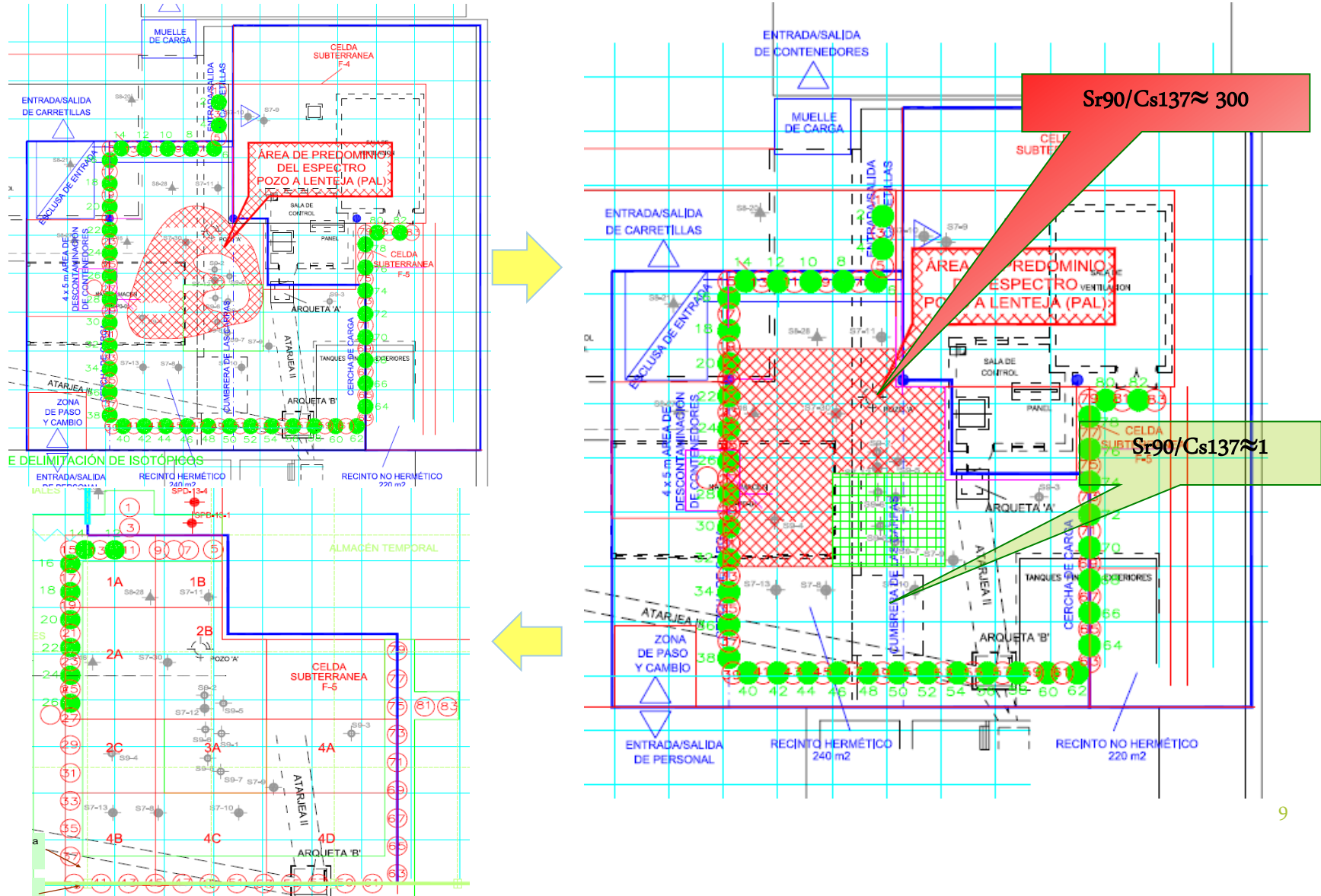
Statistical Analysis of Sr90/Cs137 values

- Two different groups of samples are clearly identified
- Two different isotopic zones were defined:
 - $Sr/Cs = 1$ (FCL)
 - $Sr/Cs = 300$ (PAL)



ISOTOPE	FCL % TOTAL	PAL % TOTAL
Pu-238	0.1150%	0.0007%
Pu-239	0.3730%	0.0023%
Pu-241	2.2900%	0.0140%
Sr-90	44.3000%	99.7000%
U-234	0.1290%	0.0008%
U-235	0.0122%	0.0001%
U-236	0.0079%	0.0000%
U-238	0.0496%	0.0003%
Am-241	0.1920%	0.0012%
Cs-137	52.5000%	0.3190%

Initial radiological characterization: Distribution of contaminants



Execution Works

Execution Works: objectives

- Objectives of remedial actions :
 - To segregate contaminated soil and no contaminated soil in order to release the clean soil coming from the excavation.
 - The soil and subsurface, after the soil removal activities, have to meet the radiological requirements and then to fill the excavated area with clean material.

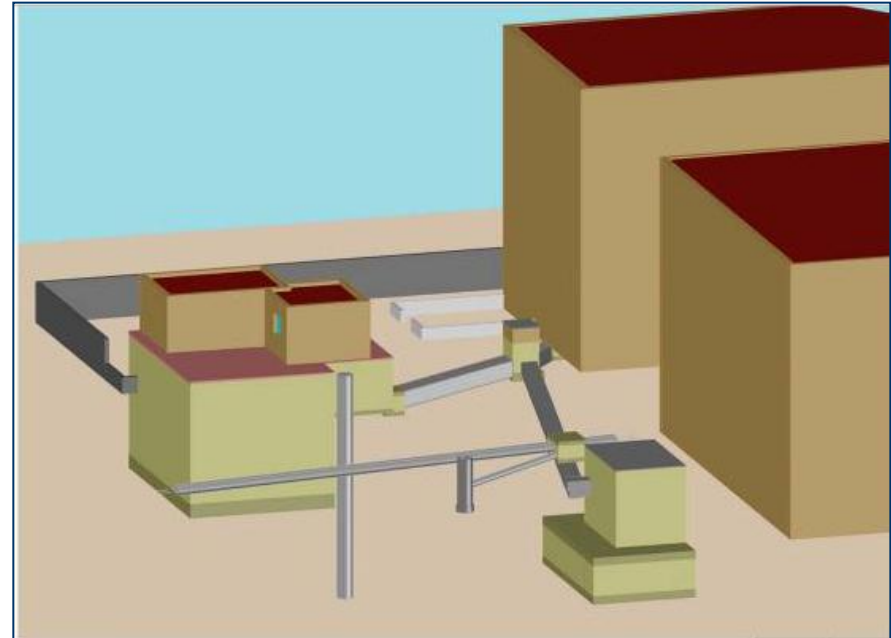
Radiological criteria

- **Material Clearance levels:** European Commission Recommendations RP122 (soil removed)
- **Building rubble, Structure and building Surfaces Clearance levels:** EC Recommendations RP 113
- **Soil: release levels (top 15 cm).**
 - *100 μ Sv/year Industrial Worker Scenario*
 - *1 mSv/year Resident Farmer Scenario (if Institutional Control Fails)*
 - *CALCULATION: RESRAD v6.4*
- **Subsurface Soil:** no residual activity at depth

	Material Clearance	Soil Release
Sr-90	1 Bq/g	0,62 Bq/g
Cs-137	1 Bq/g	0,86 Bq/g

Execution Works: preparatory works

- Structures demolition
- Underground pile wall (50 m perimeter, 15 m deep = 425 m³) to content the excavation area





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Execution works: Preparatory works



Execution works



450 m²



1 m. deep

Execution works



Execution works: Final Situation



9,20 m

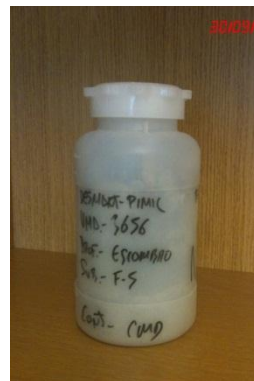
In-situ radiological characterization and material segregation

In-situ radiological characterization and material segregation

OBJECTIVE:

- To segregate material free release, VLLW and LILW
- To assign isotopic composition (scaling factors) to each waste container (*)

(*) Sample of each container (metallic box, Textile-Bag)



In-situ radiological characterization and material segregation

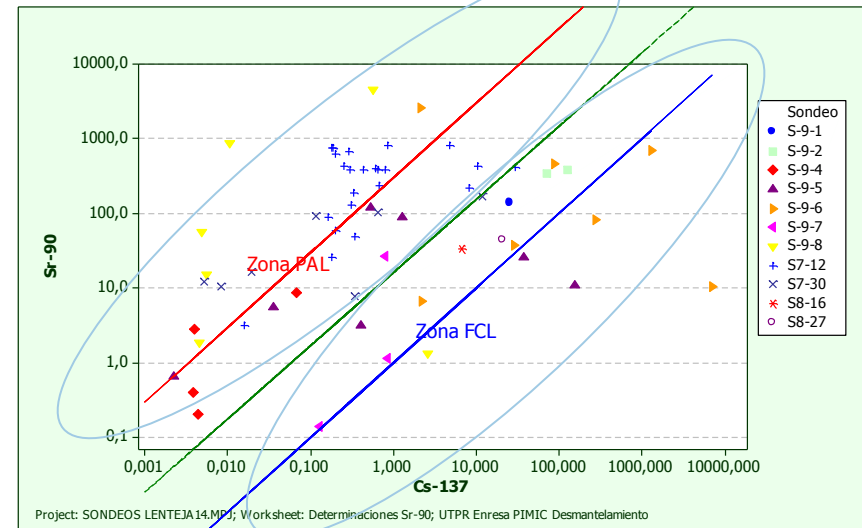
$Cs137 < 0.5 \text{ Bq.g}^{-1}$
 AND
 $Sr90_{LB} < 1 \text{ Bq.g}^{-1}$
 AND
 $Sr90 / Cs137 < 18$

$Cs137 \geq 0.5 \text{ Bq.g}^{-1}$
 OR
 $Sr90_{LB} \geq 1 \text{ Bq.g}^{-1}$
 OR
 $Sr90 / Cs137 \geq 18$

CANDIDATE TO FREE RELEASE (FCL)

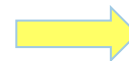
FCL Sr/Cs= 1

Sr/Cs ≈ 18



RAD WASTE (FCL/PAL)

PAL Sr/Cs= 300



$Sr < 1 \text{ Bq/g}$
 $Cs < 1/300 \text{ B/g}$

In-situ radiological characterization and material segregation

1st { Material Origin (Geo) + Characterisation Method (determ. Sr/Cs \times 18)
= isotopic composition assignation (Sr/Cs)



2nd { Cs137 value
Sr-90 value
Dose Rate
Contamination

Material for free release
VLLW
LILW

Quality Control :

5% radiochemical determination of Sr90
1% gamma spect. Gross alfa and beta activity



Material for free release

MATERIAL CLEARANCE

Clearance Process

Based on “Box-Counter”, a four germanium detector for Gamma spectrometry.



RAD WASTE

Disposal at El Cabril

VLLW & LILW are transported to Spanish disposal center of El Cabril



Excavation completed:

- **66 % Released Material:**
 - 1,878 tons
- **34 % Radioactive waste**
 - VLLW (961 tons)
 - LILW (7 tons)



Final radiological survey

Final radiological survey



Objective: to demonstrate that radiological criteria are met:

- Walls (surface clearance levels RP113)
- Soil:
 - top 15 cm (release levels)
 - At depth (no residual activity)

Final radiological survey

- Wall surface: MARSSIM methodology (Nureg 1575)
 - Scan surface ($1 \times 1 \text{ m}^2$) using scintillation counters (beta counter for surface contamination)
 - Static measurements: 13 locations for each survey unit (2)

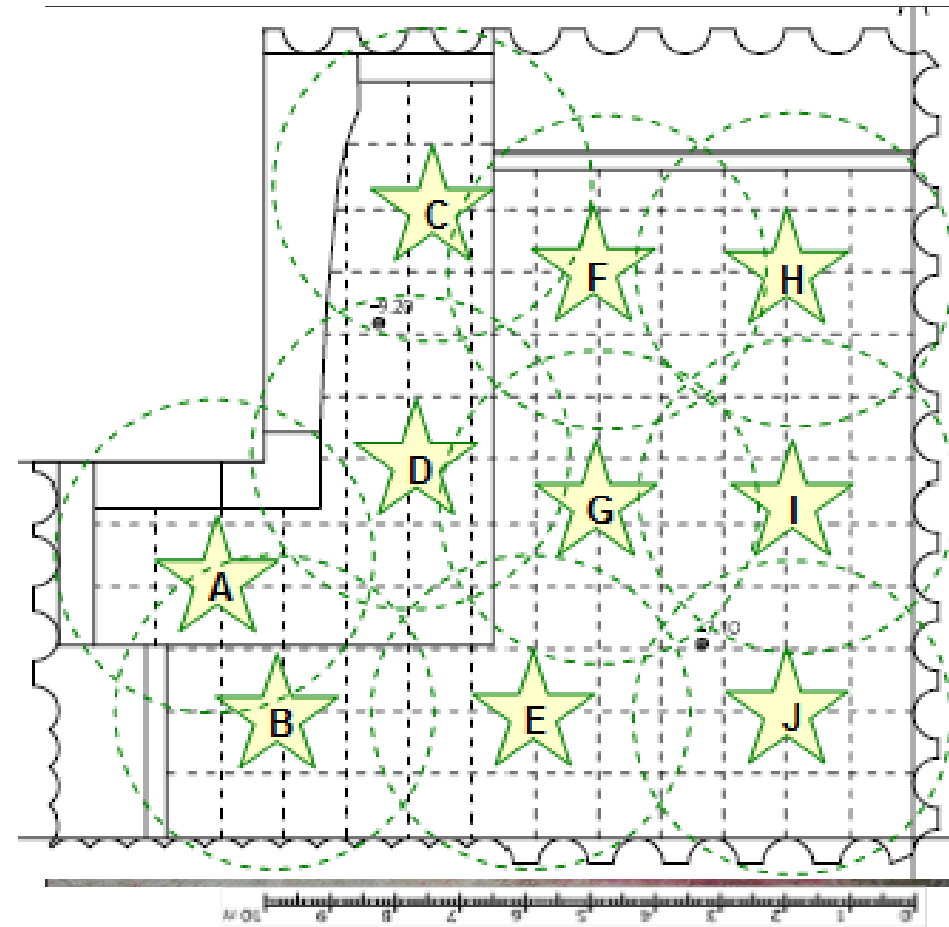


Final radiological survey

Soil and subsurface:

1. Checking the top 15 cm (MARSSIM methodology)

- Scan surface (1 x 1 m²) by using scintillation counters (beta counter)
- Scan surface by using INa detector (100 % coverage)
- Static measurements: 15 locations Sodium iodide detector (top 15 cm)



Number calculated according
Marssim statistical test. Pattern
(grid)

Final radiological survey

2. Depth Checking:



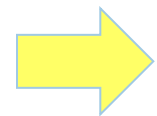
- 15 borehole at 2 m deep in the static measures locations
- 6 judgmental borehole at 6 and 8 m deep.
- 3 samples were obtained from each borehole

Final radiological survey

Final radiological survey results:

1. Soil and subsurface:
 - The top 15 cm: below release levels
 - No residual activity at depth.
2. Walls: residual activity below clearance levels for reuse.
3. Walls were insulated using a system of shotcrete.
4. Lenteja excavation was release from radiological requirements and the filling was performed as conventional work.





Final radiological survey



Conclusions

Three radiological characterization processes:

1. Initial radiological characterization:

- Scope of work (surface and depth, volume of soil)
- Management of materials (isotopic composition/scaling factors, rad-waste, material clearance)

2. In-situ radiological characterization:

- Segregation of material (soil removed) for release and rad-waste.

3. Final radiological survey:

- Verification that the resulting excavation and subsurface fulfill the regulatory requirements.

Previously the filling, the radiological final report was submitted to the Spanish Regulatory Authority



Thank you for your attention