RADIOLOGICAL ASSESSMENT OF AN AREA WITH URANIUM RESIDUAL MATERIAL

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OBJECTIVES

DISPOSAL OF URANIUM RESIDUAL MATERIALS in a specific area was modelled in order to evaluate the potential radiological dose to general public and to determine the site specific derived concentration level (DCLs) in soil according to the radiation protection criteria applied.

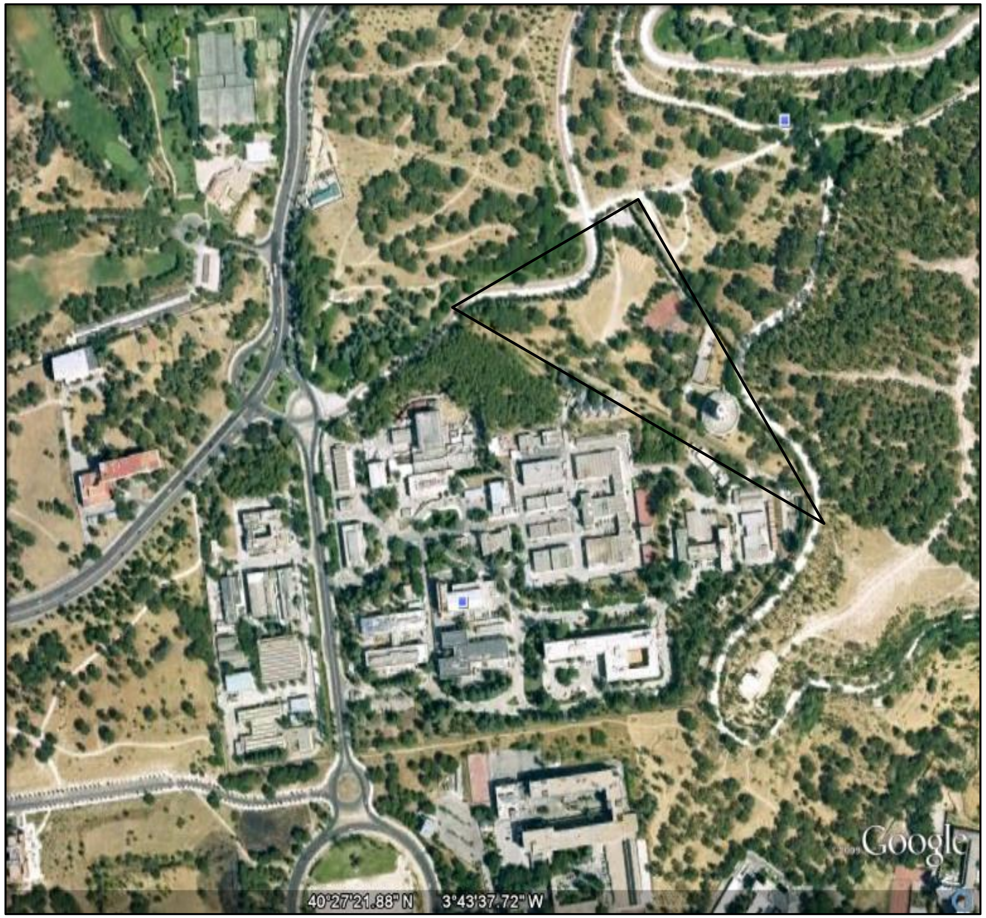
The dose modelling approach used to develop site specific DCLs for the CIEMAT site.

Scenario, and applicable exposure pathways to develop site specific DCLs, along the assign parameters values and computer code selected to represent the dose models are described. Dose modelling results and the calculate DCLs are discussed.

SITUATION CIEMAT

CIEMAT is developing since 2000 a plan to improve its facilities, in order to recover the infrastructure for conventional uses, giving up its status as nuclear facility.

The scope of this project is broad and one of its tasks is the <u>remediation of land with uranium residual materials</u>.



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The scope of this project is broad and one of its tasks is the remediation of land with uranium residual materials.

- Case an affected land area where, as a result of a past project to extract uranium from ores, a small amount of residual tailings materials mixed with conventional building residues were deposited to level the surrounding ground.

- Area is under institutional control and is used as recreational zone for the public.

RADIOLOGICAL CRITERIA

Several international recommendations from:

International Atomic Energy Agency

International Commission on Radiological Protection (ICRP-82)

Dose of the order of a few mSv per year are considered as acceptable.

ICRP-82 is established as difficult to justify intervening in situations where the total dose (including the natural background) are under a Reference Generic Level of 10 mSv per year. The national authorities may choose different values depending on their own situations. In practice, relevant authorities for European countries have decided as values for various "de facto" situations in the range of reference dose of 0.1 to 1 mSv per year.

The Spanish regulatory Body (CSN) has decided for PIMIC:

- A reference dose value of 0.1 mSv per year as "radiological approach"
- Higher values would be acceptable in situations arising from the past which must be justified with an optimization study approved by the CSN.

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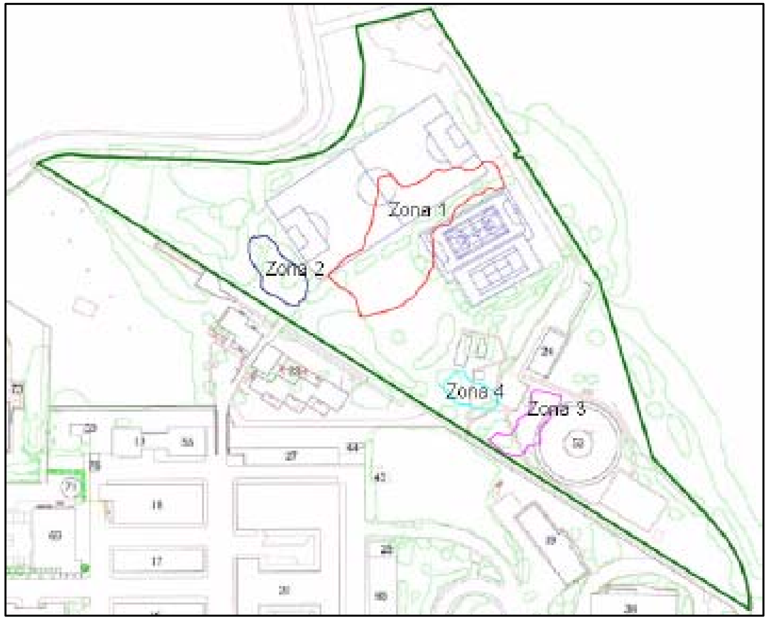
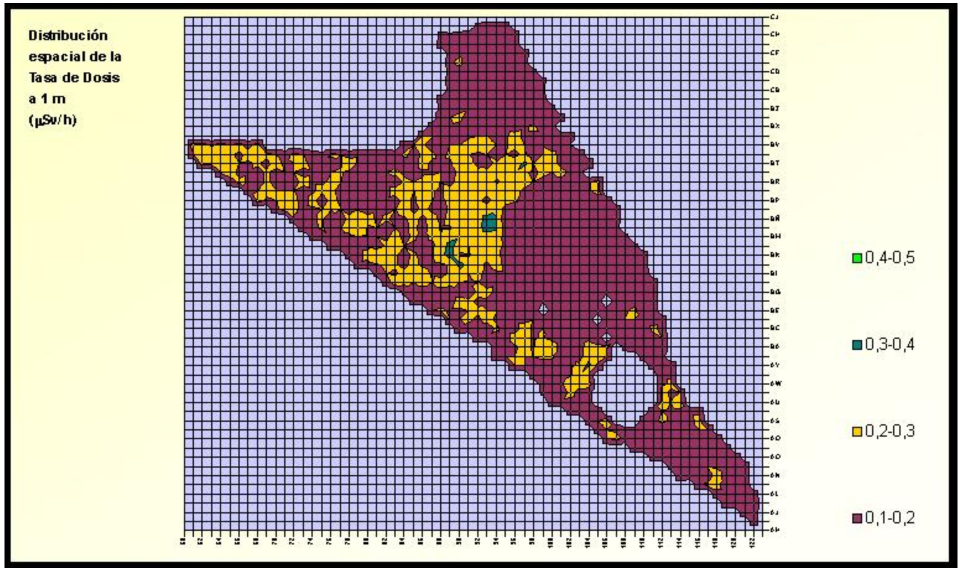
RADIOLOGICAL SITE CHARACTERIZATION

Several surface and drilling samples were taken and the Laboratory for Radiological Protection Measures at CIEMAT made their radioactivity analysis.

As a result of this characterization: it was observed that the naturally occurring radionuclides that were deposited in the site were essentially: ^{226}Ra and its descendants, ^{230}Th and a lower concentration of Uranium (^{238}U, ^{235}U and ^{234}U) and its progeny.





Scenario and Exposure Pathways

Evaluate potential dose for the public for a recreational scenario and dose calculations were conducted for the maximally exposed receptor.

Exposure pathways considered for the public that visit the recreational was:

external irradiation,

inhalation of particles due to resuspension of soil,

inadvertent ingestion of soil particles

inhalation of 222Rn and descendents

- Estimated length of stay of 20 hours per week throughout the year have been considered
- Represent a visitor spends a time 1040 hours per year (12% of the hours of the year)

Not consider Groundwater migration. Aquifer 80 m deep

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Input Parameters and Dose Model Computer Code

- Based on the site specific data, obtained from the measurements made and from the reports made available
- Unavailable local data were adopted from default values recommended by RESRAD ONSITE
- These default values were assessed and chosen to be the most realistic for the conditions on site
- As normal practice in impact assessment, the values were chosen in such a way that use of these values in any situation would not result in underestimation of the dose

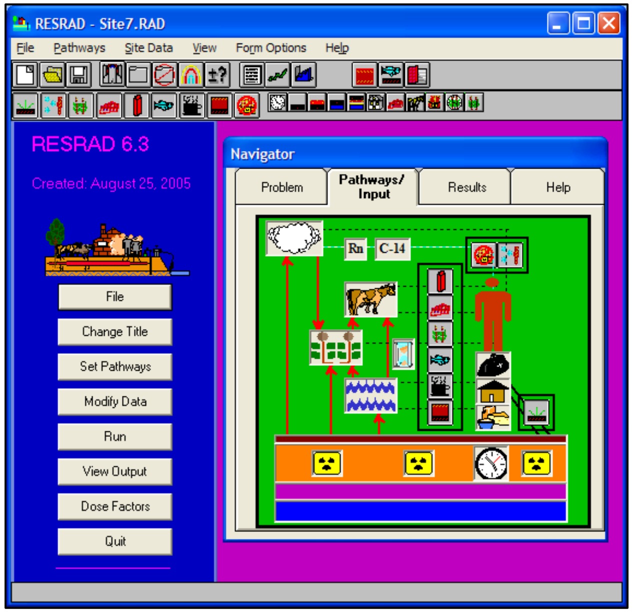

Table 1. Input parameters for Recreational Scenario

Parameter	Value
Non adverted Ingestion of soil	100 mg d^{-1}
Dust load in air	100 µg m^{-3}
Inhalation rate	8400 m3 y^{-1}
Exposure time	30 years
Precipitation rate	0.436 m y^{-1}
Occupancy factor	12 % annual
Density of soil	1.4 g cm^{-3}

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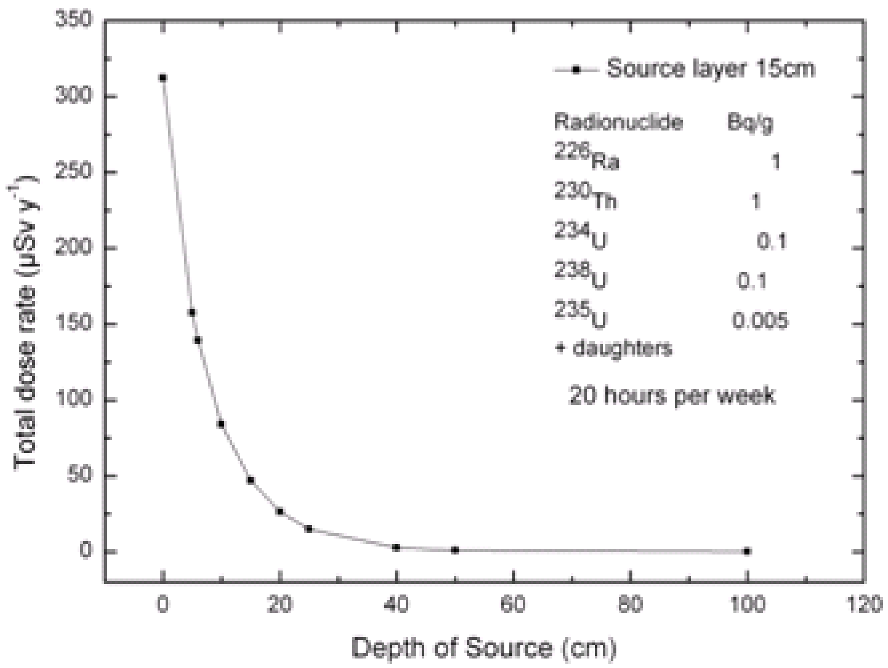
RESULTS: Variation of Dose with Contamination Depth

- For a soil coverage of 10 cm or more, the dose is lower than the reference for all pathways of exposure

- If there is no higher concentration than natural background in surface soil, this coverage thickness would be enough to shield the additional radiation caused for the presence of radionuclides in deeper areas.

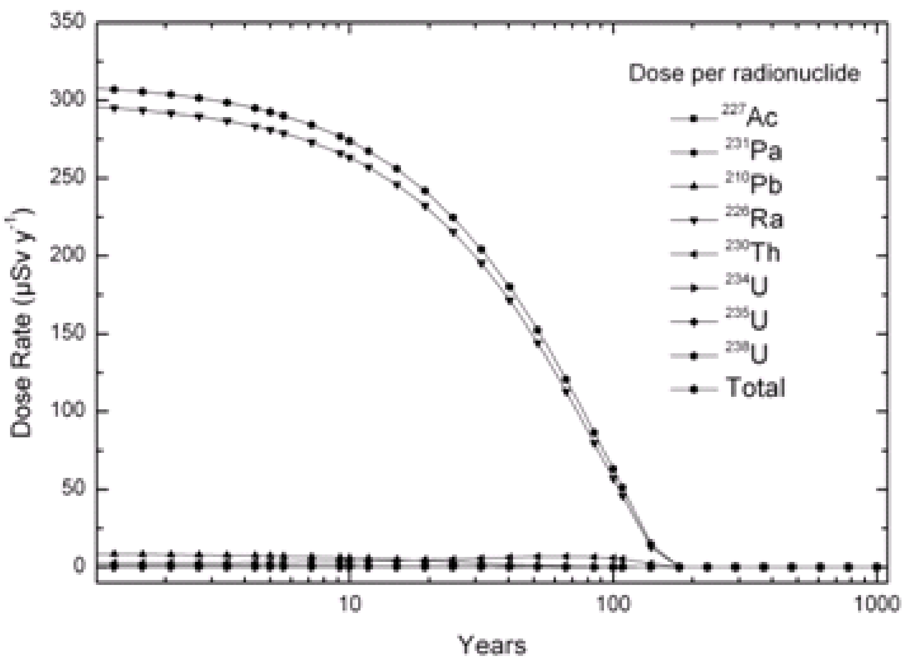
Figure 1: Changes in the Total dose rate with contamination depth for a vein of 15cm thickness



RESULTS: Variation of Dose with time

- Considering the whole area with a uniform surface contamination in the first 15 cm of soil
- Results for the whole area showed that the external gamma irradiation produces the greatest contribution to the dose and the responsible of that is the ^{226}Ra with its descendants.

Figure 2: Variation of annual dose rate as a function of time for radionuclides present in soil.



RESULTS: Variation of Dose with Contamination Depth

- Effect of the coverage layer in the reduction of the gamma external dose and the lack of influence of the ingestion and inhalation pathways.
- The influence of gamma external dose due to ^{226}Ra and its descendants is determining if the topsoil does not contain additional contamination to natural background

Figure 3: Gamma dose rate variation, at 1 m of soil, for a continuous source layer of 15 cm with concentration of 1 Bq g⁻¹ of ^{226}Ra at different depths, with and without clean soil cover.

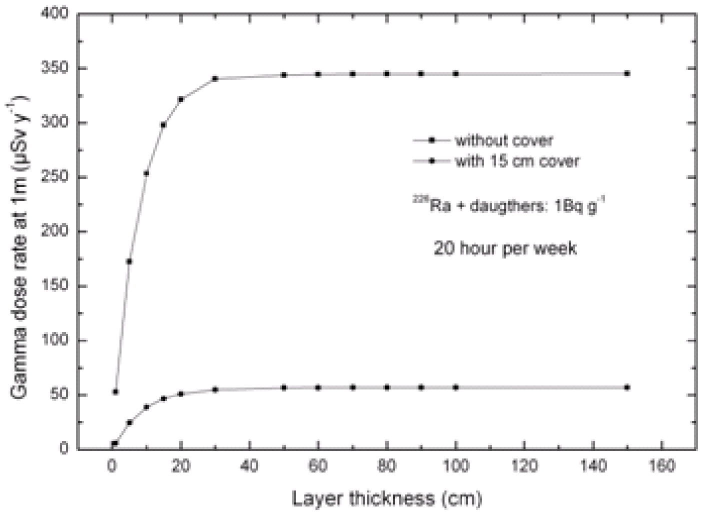


Table 2. Calculate Doses with and without clean Soil cover

Exposure Pathways	Without cover		With cover	
	Dose Rate (µSv y⁻¹)	Fraction (%)	Dose Rate (µSv y⁻¹)	Fraction (%)
Gamma External Radiation	298.9	95.73	46.68	99.65
Soil Ingestion	11.0	3.52	0	0
Inhalation	2.15	0.69	0	0
Radon Inhalation	0.17	0.05	0.17	0.35
Total Dose	312.2	100	46.84	100

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RESULTS: Calculation of Derived Concentrations Levels

- The soil concentrations for each radionuclide to ensure that individually, do not provide an exceeding dose of 0.1 mSv per year

- Calculation of derived guidelines concentration levels to apply the MARSSIM methodology.

- It should be noted that it is applied to surface contamination in the first 15cm and does not include scenarios derived from depth contamination.

Table 3. Calculate Derive Concentration Levels

Radionuclide	DCLs (Bq g^{-1})
^{226}Ra	0.34
^{230}Th	41.50
^{238}U	19.52
^{234}U	99.14
^{235}U	4.24

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CONCLUSIONS

- The involved radionuclides in some measurements of higher values than natural background are typical of tailing material once the uranium has been extracted, and they represent natural series, also present in all types of soils. The external gamma exposure due to ^{226}Ra and its descendants is considerably predominant.

- All depths greater than 50 cm, the presence of materials containing ^{226}Ra and its descendant has no influence on the external gamma dose at the surface, due to the shield provided by the soil.

- This study recommends the use of the value of 0.1 mSv per year, determined by the regulatory body as radiological criteria for the release of contaminated soil sites at CIEMAT.

CONCLUSIONS

- It is important to highlight that this is not and unconditional release of the area. Applying this value as a derived concentration level and comparing with the results of measurements on the ground, some areas with a concentration of activity slightly higher than latter were found.

- In these zones the remediation proposal has been to cover with a layer of 15 cm of clean material. This action represents a reduction of 85% of the dose and ensures compliance with the reference dose.