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Assessment of the resuspension factor for alpha airborne particles applicable to dismantling of natural uranium graphite gas reactor sites

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CHANGER L'ÉNERGIE ENSEMBLE

Assessment of the resuspension factor for alpha airborne particles applicable to dismantling of natural uranium graphite gas reactor sites

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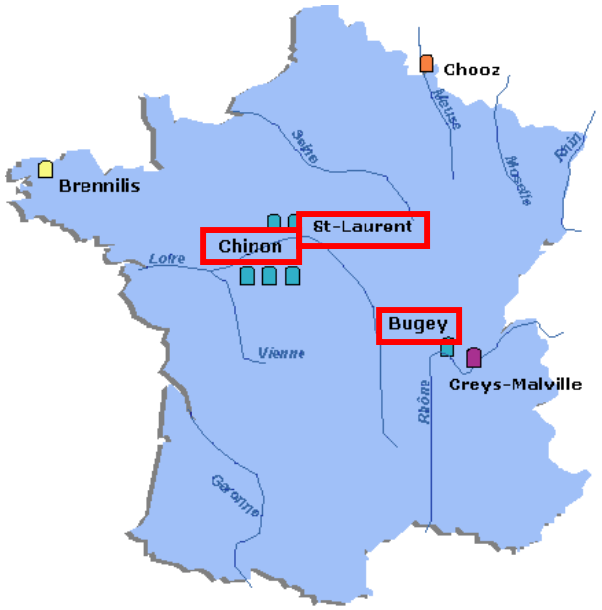
1. Context

- 19 operating PWR units
- 6 dismantling sites
  - 3 sites of natural uranium graphite gas for dismantling

- Alpha risk exposure is more common on dismantling workplaces
  - Significant alpha contamination may occur due to incidents on the nuclear fuel during the operation phase
  - higher frequency of dry contamination
  - work generating a significant resuspension of dust and airborne particles (pipe cutting, grinding for example)



1 réacteur à eau pressurisée (REP)
Chooz A (300MW) : 1967-1991

1 réacteur à eau lourde (REL)
Brennilis (70 MW) : 1967-1985 (EDF/CEA)

6 réacteurs de la filière Uranium naturel / graphite-gaz (UNGG)
Chinon A1 (70MW) : 1963-1973
Chinon A2 (200MW) : 1965-1985
Chinon A3 (480MW) : 1966-1990
Saint-Laurent A1 (480MW) : 1969-1990
Saint-Laurent A2 (515MW) : 1971-1992
Bugey 1 (540MW) : 1972-1994

1 réacteur à neutrons rapides (RNR)
Creys-Malville (1240MW) : 1986-1997

2. Resuspension Factor (FMES) for alpha airborne particles

- Resuspension factor depends on many parameters :
  - homogeneity & type of surface contamination
  - size, density & chemical composition of contaminants
  - air movement caused by ventilation
  - action of the workers on the site & nature of work
  - …

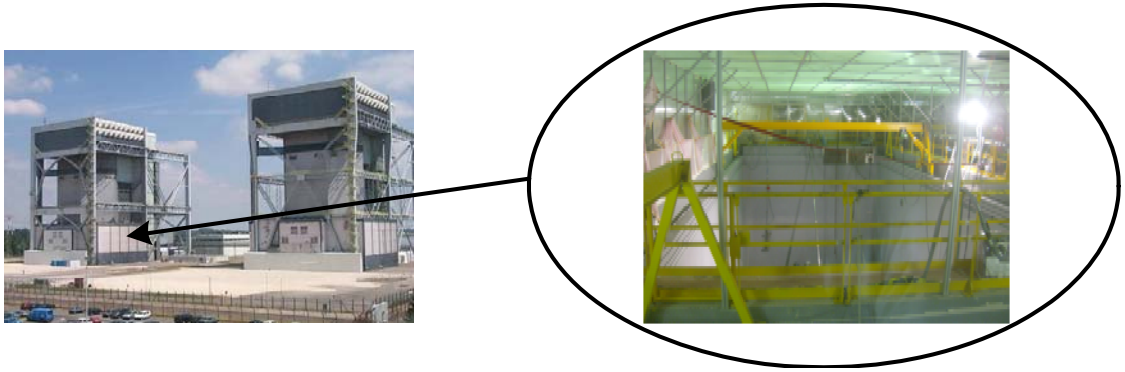
- A general approach has led to the following definition :

$$FMES\,(m^{-1}) = \frac{Av\,(Bq/m^3)}{As\,(Bq/m^2)}$$

- Why do we measure a resuspension factor ?
  - to define the appropriate protection for workers
  - because contaminant airborne particles inhalation is a major risk

3. Experimentation : *plant & site selection*

- Plant : Unit #1 of Saint Laurent A
  Site : Located in the pools



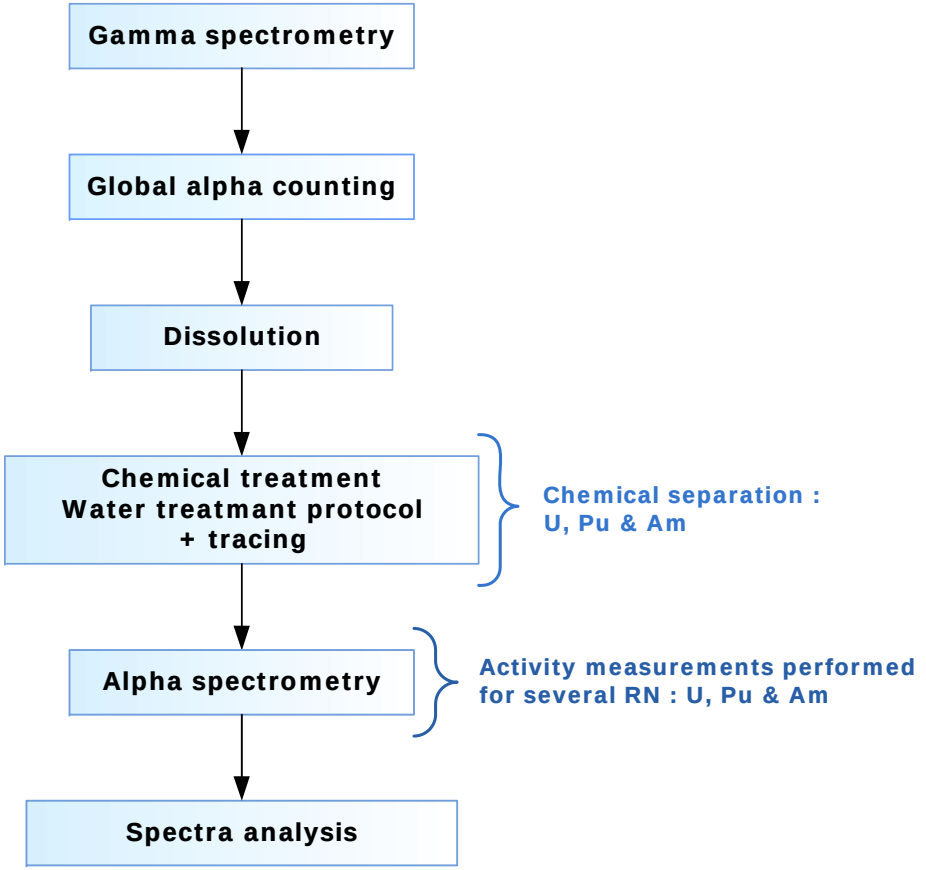
- Why did we choose this workplace ?
  - large dimension of site
  - low dose rate
  - alpha surface contamination less than 10 Bq/cm^2
- The walls of the pools were decontaminated in the late 90s.

3. Experimentation :

Sampling

- Sample collection :
  - Lasted two weeks
  - Surface & volumic samples
  - Static & dynamic conditions
  - Temperature & humidity
- Sampling :
  - Surface activity assessment
    ➔ 42 surface samples
  - Volumic activity assessment
    ➔ 11 volumic samples
  - Size of airborne particles
    ➔ 3 samples

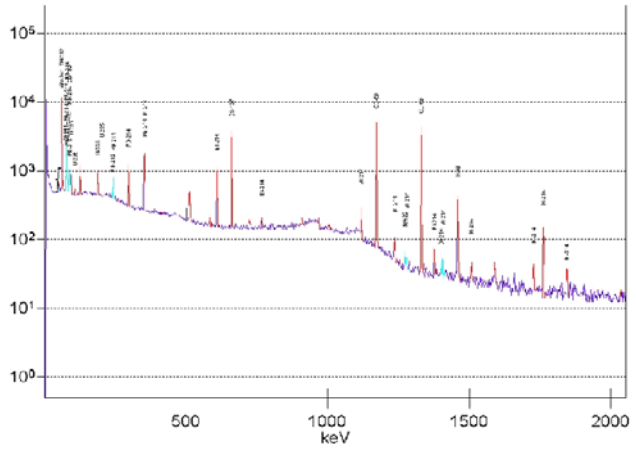
Analysis program



3. Experimentation : *results*

Gamma spectrometry

- 3 radionuclides identified recursively in all the treated samples : ^{60}Co, ^{137}Cs and ^{241}Am
- Various activities depending on the samples



Gamma spectrum

Alpha spectrometry

- No significant activity for ^{235}U and ^{238}U
- Presence of ^{238}Pu, $^{239,240}Pu$ and ^{241}Am
- No other radionuclide identified
- Surface activity : variable depending on the samples
- Volumic activity : little dispersion
- Size of airborne particles : between 4 µm et 10 µm

4. Discussion

Assessment of the resuspension factor for alpha airborne particles :

- Average resuspension factor calculated for each radionuclide of interest in static conditions and in dynamic conditions
- Dynamic FMES, i.e. calculated during human activity (calibrated walking) = the most representative because it is the closest to actual working conditions in the dismantling workplaces

Comparison with similar measurements previously carried out at an operating PWR unit :

	Cattenom 2001 (operating)	SLA 2008 (dismantling)
FMES alpha	$1{,}2\ 10^{-6}\ m^{-1}$	**$9{,}2\ 10^{-5}\ m^{-1}$**
Size of airborne particles (µm)	≈ 1 µm	**4 à 10 µm**

- The difference in the size of particles is likely to explain the difference in the FMES value

5. Conclusions

- Knowing the particle size is a relevant and necessary data to interpret the value of FMES

- FMES is evaluated in terms of a specific workplace : the extrapolation to all sites would be difficult

- The recommended resuspension factor, in the case of human activity (like displacement) which doesn't generate radioactive airborne particles, and for pool specific site at the plant unit#1 of Saint-Laurent A, is :

$$\mathbf{FMES = 10^{-4}\ m^{-1}}$$

Thank you for your attention