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# ALARA in Decommissioning and Site Remediation

## The site remediation of the FBFC fuel cycle facility in Dessel, Belgium

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*Bel V, Belgium*

# Nuclear industry & Decommissioning in Belgium

## Nuclear Industry in Belgium

- 7 Commercial NPP
- Fuel production
- Radio isotope production
- Radioactive waste management
- R&D


## Under Decommissioning

- Belgonucléaire (MOX)
- **FBFC (Fuel Assembly)**
- Eurochemic (reprocessing)
- BR3 (pilot PWR)
- Best Medical (radioisotopes)

## Decommissioned

Thetis Research Reactor

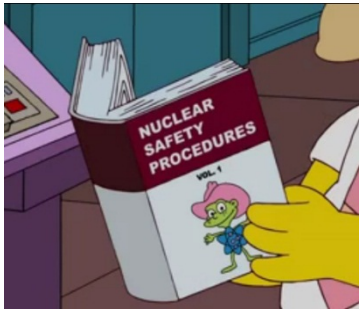
# Belgian Regulatory framework for decommissioning

## Two regulators :

Radiation Protection

FANC
federal agency for nuclear control
BEL V

Safety




Security

Waste Management

NIRAS
ONDRAF

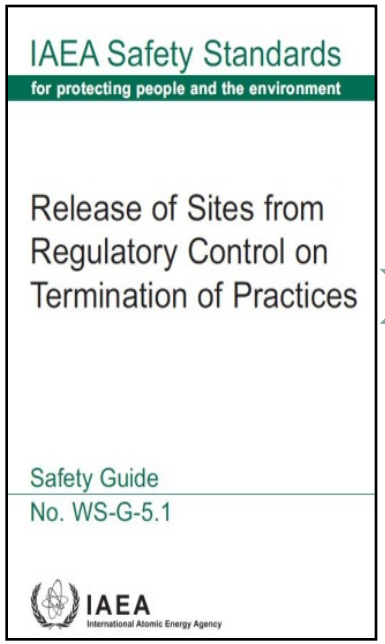
Financial/ Technical Feasibility

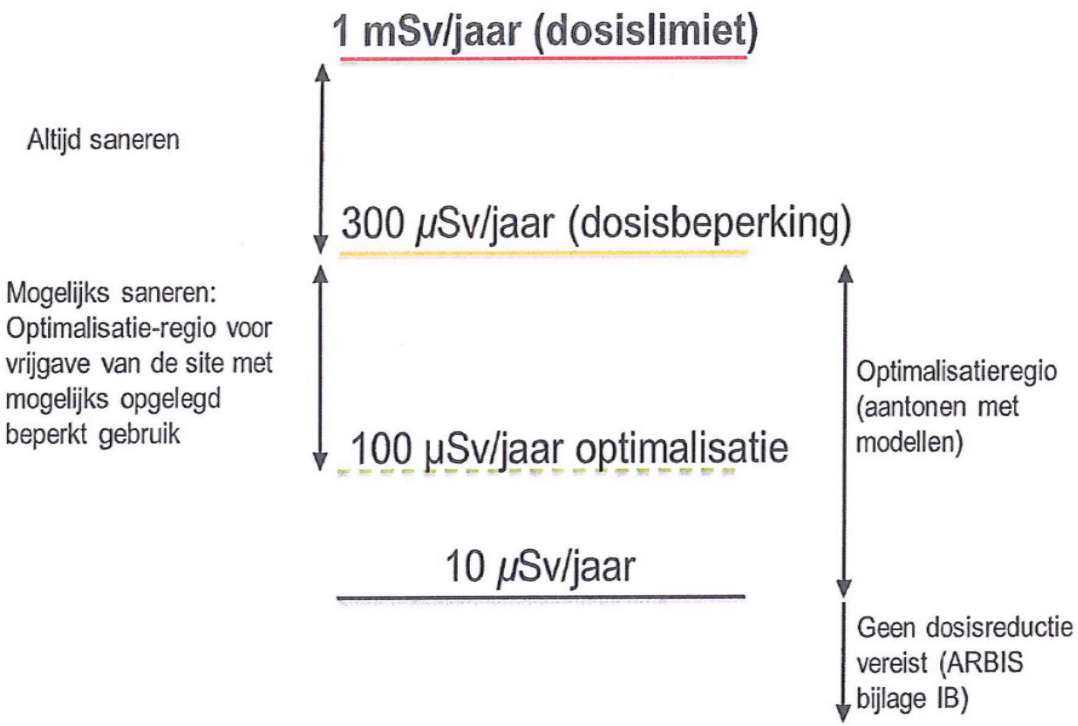
# Belgian Regulatory framework for decommissioning

## Regulatory framework in Belgium

### Belgian position on site release

Based on optimisation principles as described in IAEA WS-G-5.1:



# Belgian Regulatory framework for decommissioning

## Regulatory framework in Belgium

Belgian position on site release when the predicted end-state (= green field) is not met:

i.e. unconditional clearance based on levels as defined in RP122 part I is not possible

Conditional clearance through a license of FANC is possible (for levels above clearance levels and below exemption levels, based on 10 µSv/a))

- The operator provides a radiological impact study for disposal of soil on e.g. a chosen landfill
- The license of FANC stipulates the amount of soil to be removed and the destination (conventional landfill for hazardous waste).
- Prior to delivering the license, an agreement with the owner of the landfill site has been concluded on the acceptance of the soil. **(STAKEHOLDER INVOLVEMENT)**

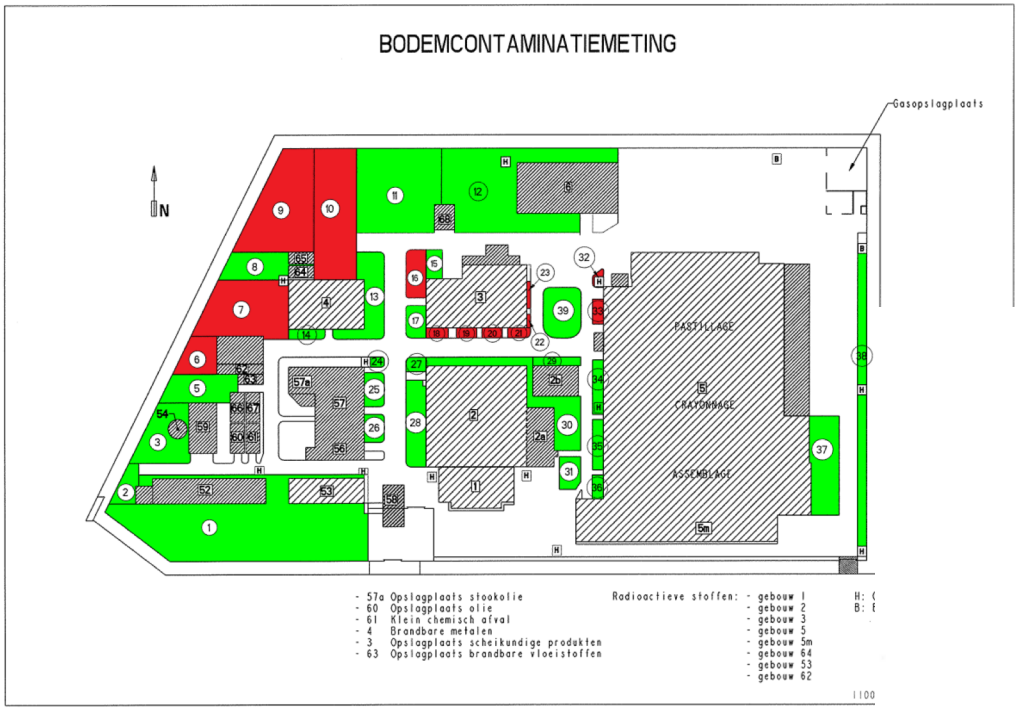
# Site remediation of FBFC fuel cycle facility

## **Site of FBFC International, Dessel, Belgium** (1960-2012)

- UO2 : pellets, fuel rods, fuel assemblies
- Gadolinium : pellets and fuel rods
- MOX : fuel assemblies
- Small components : end plugs and springs for fuel rods
- R&D powder and pellet production

# Site remediation of FBFC fuel cycle facility

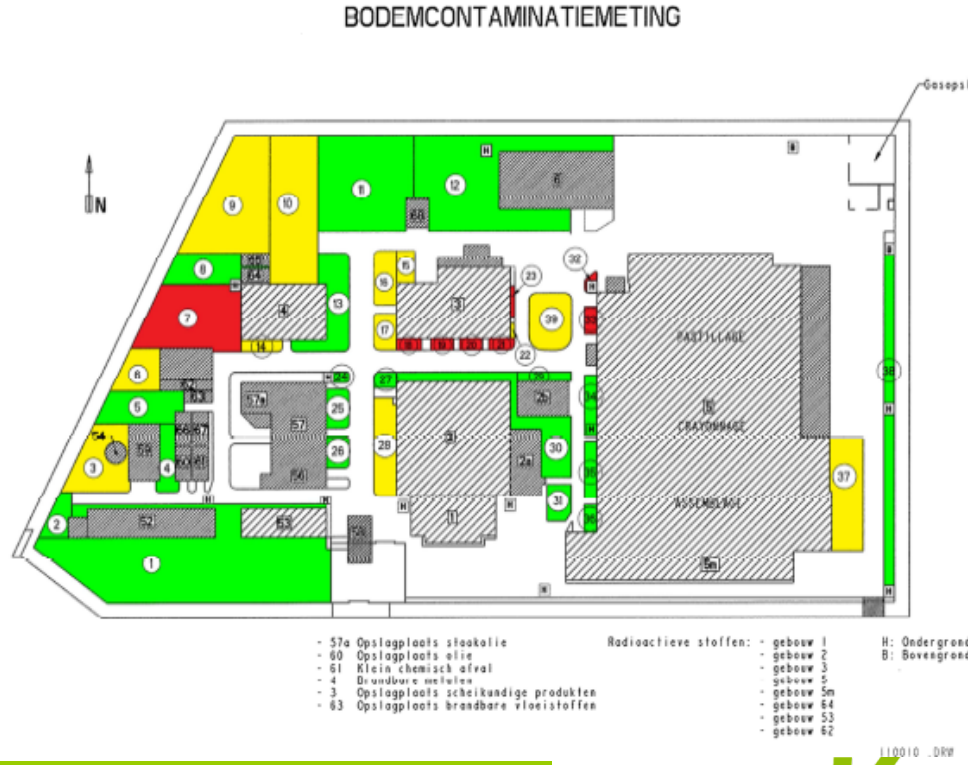
## Surveys of Site of FBFC International




Initial survey (2001)

≥ 1 Bq/g

< 0,5 Bq/g




After sand washing (2005)

≥ 1 Bq/g

≥ 0,5 Bq/g & < 1 Bq/g

< 0,5 Bq/g

# Site remediation of FBFC fuel cycle facility

## Site of FBFC International : determination of sampling scheme

Clearance based on sampling

Guidance: European Radiation Survey and Site Execution Manual (EURSSEM)

Define areas in categories:

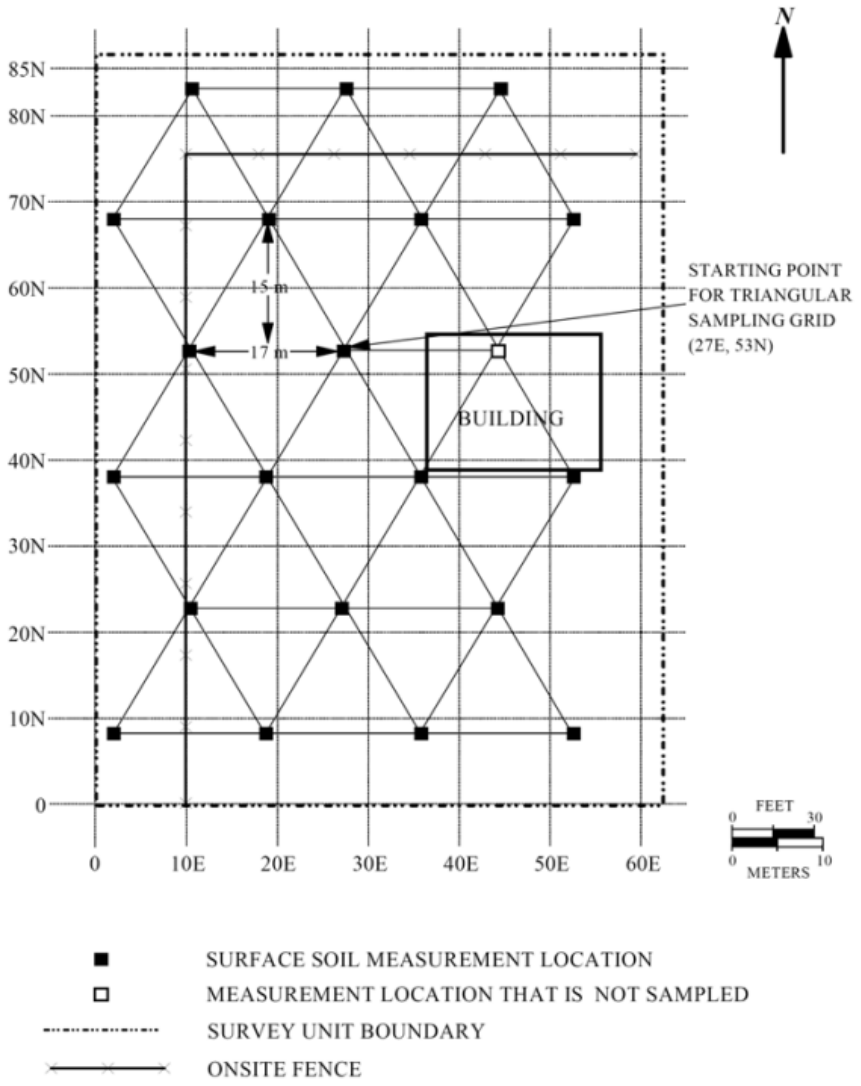
- Class 1: contamination expected ≥ 1 Bq/g
- Class 2: increased levels, no contamination ≥ 0,5 Bq/g & < 1 Bq/g
- Class 3: no contamination expected < 0,5 Bq/g

| | Class 1 | Class 2 | Class 3 |
|---|---|---|---|
| **Sampling sand (soil)** | Regular pattern, possible hot spots | Regular pattern | Random pattern |
| | Number based on initial sampling | Number based on initial sampling | Number based on initial sampling |
| **Underground structures** | 100 % | 10 % | 0 % |

# Site remediation of FBFC fuel cycle facility

## Sampling of Site of FBFC International

- Number of samples N
- Triangular pattern
- Random starting point of grid
- Sampling depth up to 2 m




*EURSSEM (fig. 3.8)*

# Site remediation of FBFC fuel cycle facility

## Surveys at FBFC International by sampling

# Site remediation of FBFC fuel cycle facility

## Evacuation routes for collected soil:

- For activities below 1 Bq/g U :
  - Redistribution on site (filling holes…)
- For activities between 1and 10 Bq/g U :
  - Specific Clearance License granted on 14/02/2018 by FANC to FBFC
  - Based on radiological impact study for landfill disposal ( < 10 µSv/a)
  - Total mass of soil : ~13 000 ton
  - Destination : Conventional Landfill for hazardeous waste (INDAVER)
- For activities above 10 Bq/g U:
  - To NIRAS/ONDRAF as radioactive waste

# Site remediation of FBFC fuel cycle facility

## Conditional Clearance : disposal on landfill for hazardeous waste

### Radiological impact study (1 and 10 Bq/g U , max. 12460 ton)

| Non-radiological workers | Type of exposure | Annual dose (µSv) |
|---|---|---|
| **Transporter (driver) of soil** | External | 1.05 |
| | Inhalation | Negligible |
| | Ingestion | Negligible |
| | **Total** | **1.05** |
| **Worker on landfill during unloading** | External | 7.3 |
| | Inhalation | 7.4 |
| | Ingestion | 0.2 |
| | **Total** | **14.9** |
| **Worker on landfill during disposal** | External | 3.3 |
| | Inhalation | 1.6 |
| | Ingestion | 0.1 |
| | **Total** | **5.0** |
| **Other worker on landfill** | External | 2.8 |
| | Inhalation | Negligible |
| | Ingestion | Negligible |
| | **Total** | **2.8** |

# Site remediation of FBFC fuel cycle facility

## Conditional Clearance : disposal on landfill for hazardeous waste

Radiological impact study (1 and 10 Bq/g U, max. 12450 ton):

< 10 µSv/a?

- Non-radiological workers at the landfill disposal site:

  Assumptions:
  - considered workers perform only one of the listed tasks
  - the job of unloading is shared by 2 workers

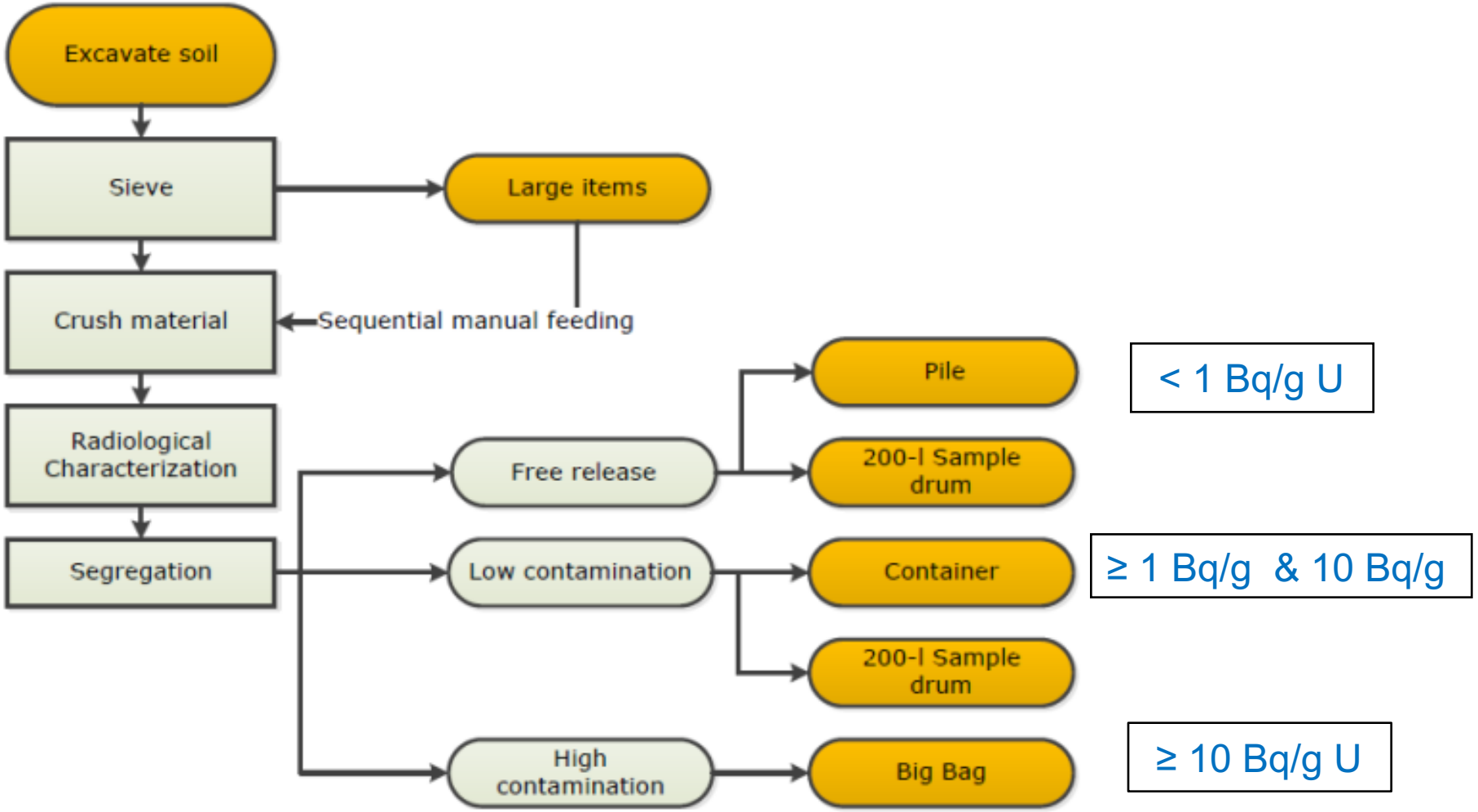
- Members of the public for all age categories:
  - living in the vicinity of the landfill,
  - cultivating a garden or even walking on the landfill

  ➢ Similar results as for non-radiological workers (< 10 µSv/a)

*Note :*
Workers on-site at FBFC : considered as occupationally exposed workers, but impact < 10 µSv/a (using protective equipment)

# Site remediation of FBFC fuel cycle facility

## FREMES : Free REIease MEasurement System




*Courtesy: NUKEM Technologies*

# Site remediation of FBFC fuel cycle facility

## Segregation of output streams by « FREMES » :

Truck loading of sand (10 ton/h)

Conveyor belt to measurement unit ($\gamma$-spectrometer)

Manual sampling (~1 sample/minute)

# Site release of FBFC fuel cycle facility….

- Since beginning of 2018 :

  ~ 9000 ton of soil has been treated,
  100 ton between 1-10 Bq/g

- Final destination after site release:

  Re-use for (conventional) industrial activities

*Acknowledgements: B. Van Assche, S. Peetermans, A. Basset (FBFC International)*

# Thank you!