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Implementation of the radiological protection principles in decommissioning: lessons learnt from three projects

P.Deboodt
Belgian Nuclear Research Centre

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Introduction

- SCK•CEN contributions for three Belgian D&D projects (a PWR, a MOX production facility, a research reactor)
- Implementation of the three basic RP principles has learnt from such opportunities…
- … in particular for the optimisation principle
- and on a potential "extension" of this principle

Let us limit the scope for today...!

justification

optimisation (ALARA)

limits

Three cases studies

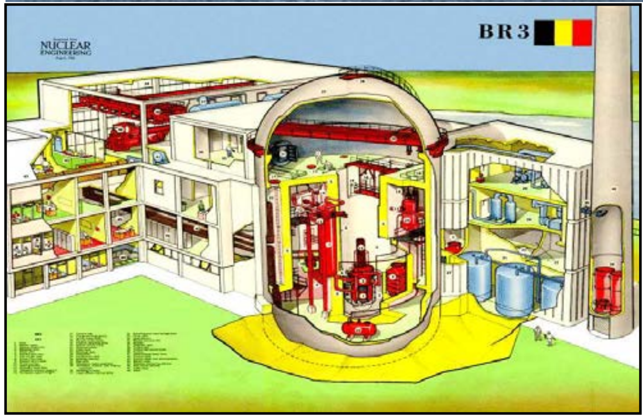
- BR3 (SCK•CEN)
- Thetis (Ghent University)
- Belgonucléaire (site of Dessel)

Case study 1
BR3 (Belgian Reactor Three) at the SCK●CEN

- First European PWR
- Became critical August 19, 1962
- Main “uses” : training, study of different geometries, different core compositions, cooling fluids
- Out of duty, June 30, 1987
- Selected in 1989 as pilot dismantling project for the European Commission

→ two main objectives :

- **comparison of cutting techniques**,
- **implementation of the ALARA principle**



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Dismantling : a broad spectrum of hazards

- Industrial (1)
  - Fire & Explosion
    - Facility demolition
    - Fire load
    - Welding and cutting
  - Mechanical
    - Heavy loads, rigging and hoisting
    - Heavy equipment and power tools
    - Vehicle movements
    - Fall protection
  - Chemical
    - Asbestos, solvents, heavy metals
  - Electrical
    - Removal of services
    - Temporary services

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Dismantling :
a broad spectrum of hazards

- Industrial (2)
  - Biological
    - Agents in ventilation systems
    - Droppings
    - Insects, animals
  - Ergonomics
    - Overhead work
    - Heat, cold, wet, slippery,
    - Limited visibility, lighting
    - Confined spaces
  - Housekeeping
    - Construction debris
    - Dismantlement debris

Dismantling: a broad spectrum of hazards

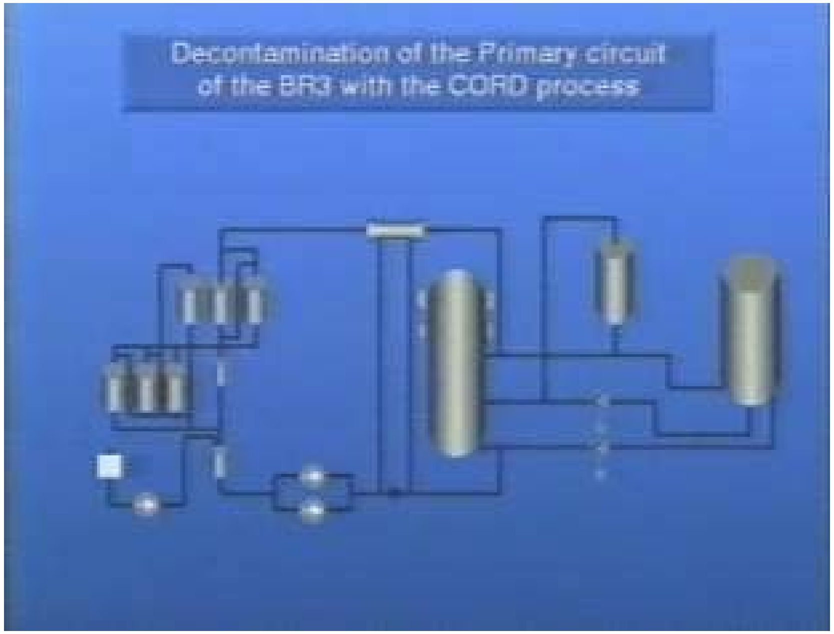
- Nuclear related risks
  - Irradiation
    - Gamma, beta, neutron
  - Contamination
    - Gamma-beta
    - Alfa
    - Internal/external
    - Decontamination
  - Criticality

First action : Implementation of an ALARA infrastructure at the SCK•CEN
BR3 as project pilot

- Support from the management
- Skilled people chosen and trained at CEPN offices in 1991
- Technical means (electronic dosimeters,…) made available
- Dedicated procedure developed
- ALARA committees (SCK•CEN, each installation)
- Local ALARA coordinator

Second action :
decontamination of the primary circuit

Dose cost : 158 man.mSv



“Avoided” Dose : ~ man.Sievert

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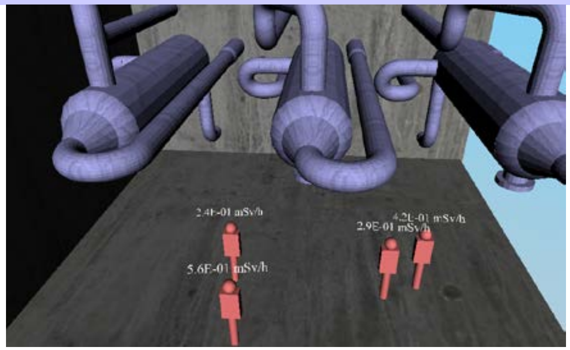
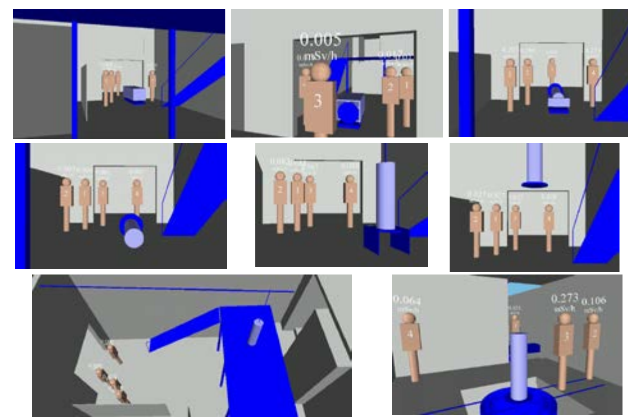
Dose analysis
VISIPLAN 3D ALARA planning tool

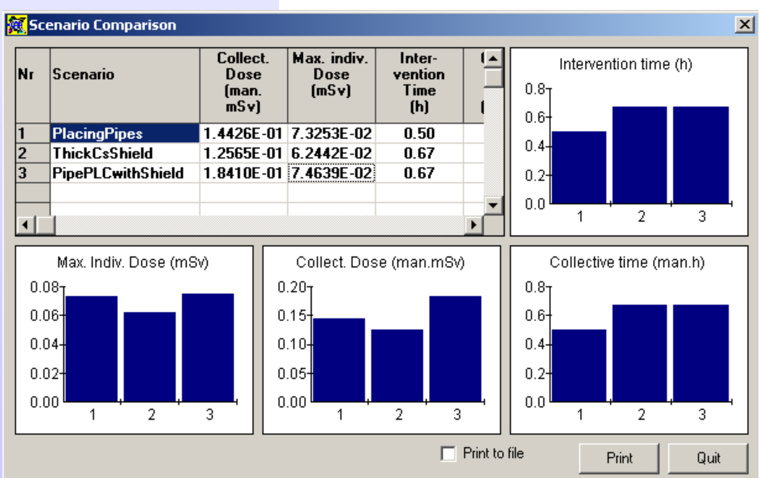
1. Analysis of individual trajectories



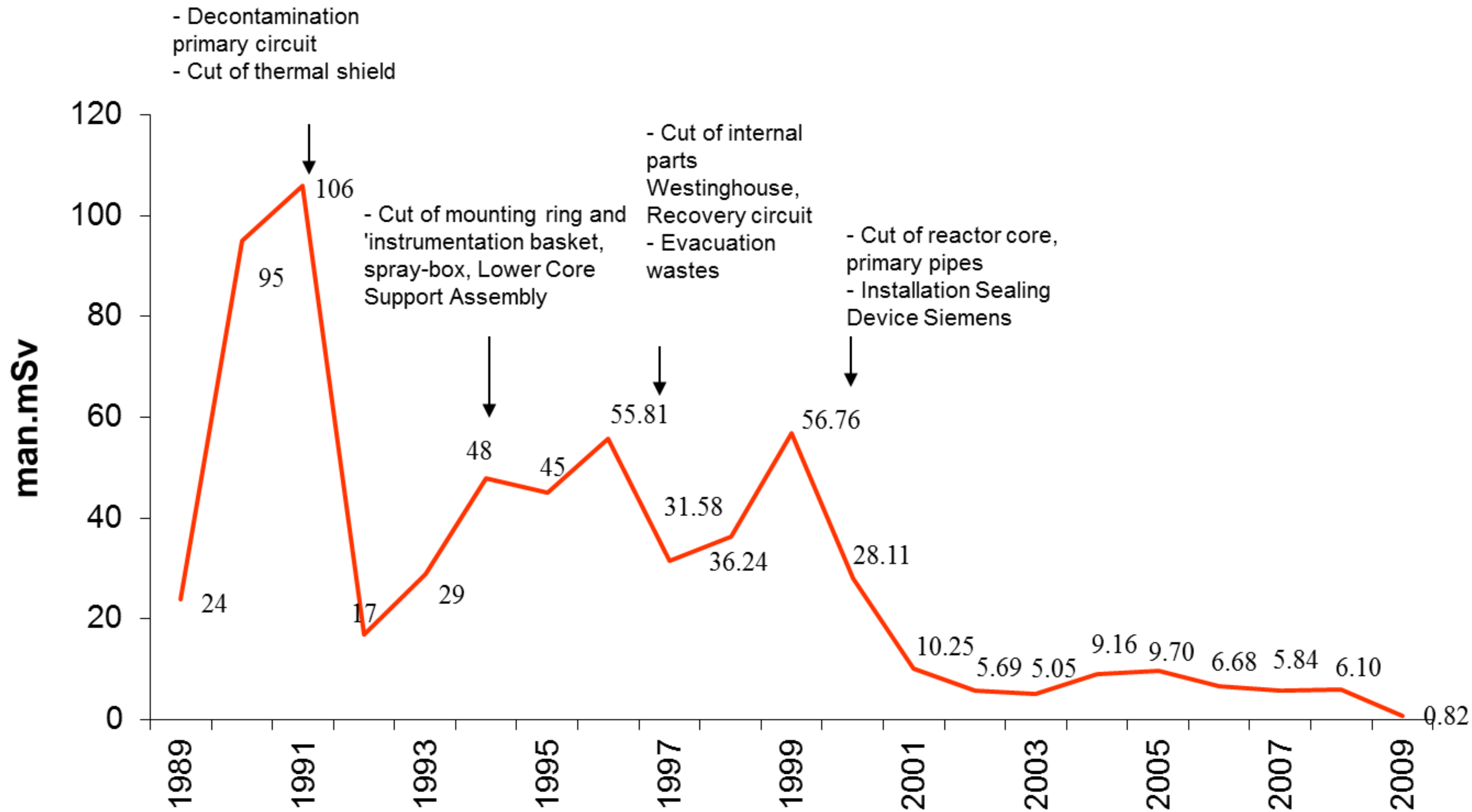
2. Analysis of scenarios



3. Scenario comparison



The total collective dose, between 1989 et 2009, based on the TLD, is 631,79 man.mSv



Industrial risks :
Feedback from BR3 decommissioning project

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→ transfer of risk: the ladder syndrome

→ priority of the risks removal of asbestos from controlled areas

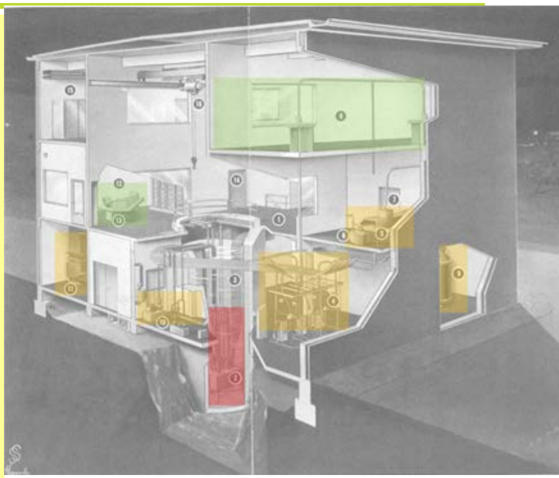
- (R – NR) interactions
- impact of/on the nuclear and non nuclear regulations

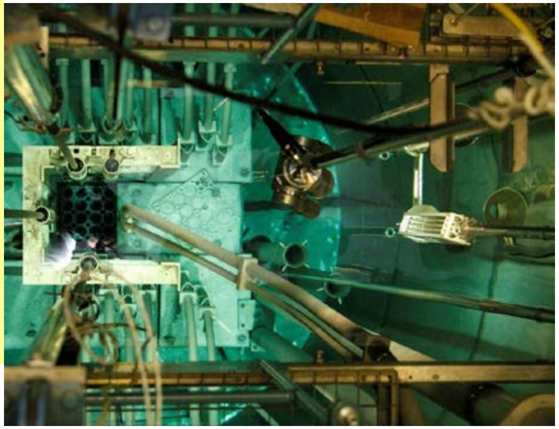
→ Need for an "integrated"* risk management

* Global, Holistic, …

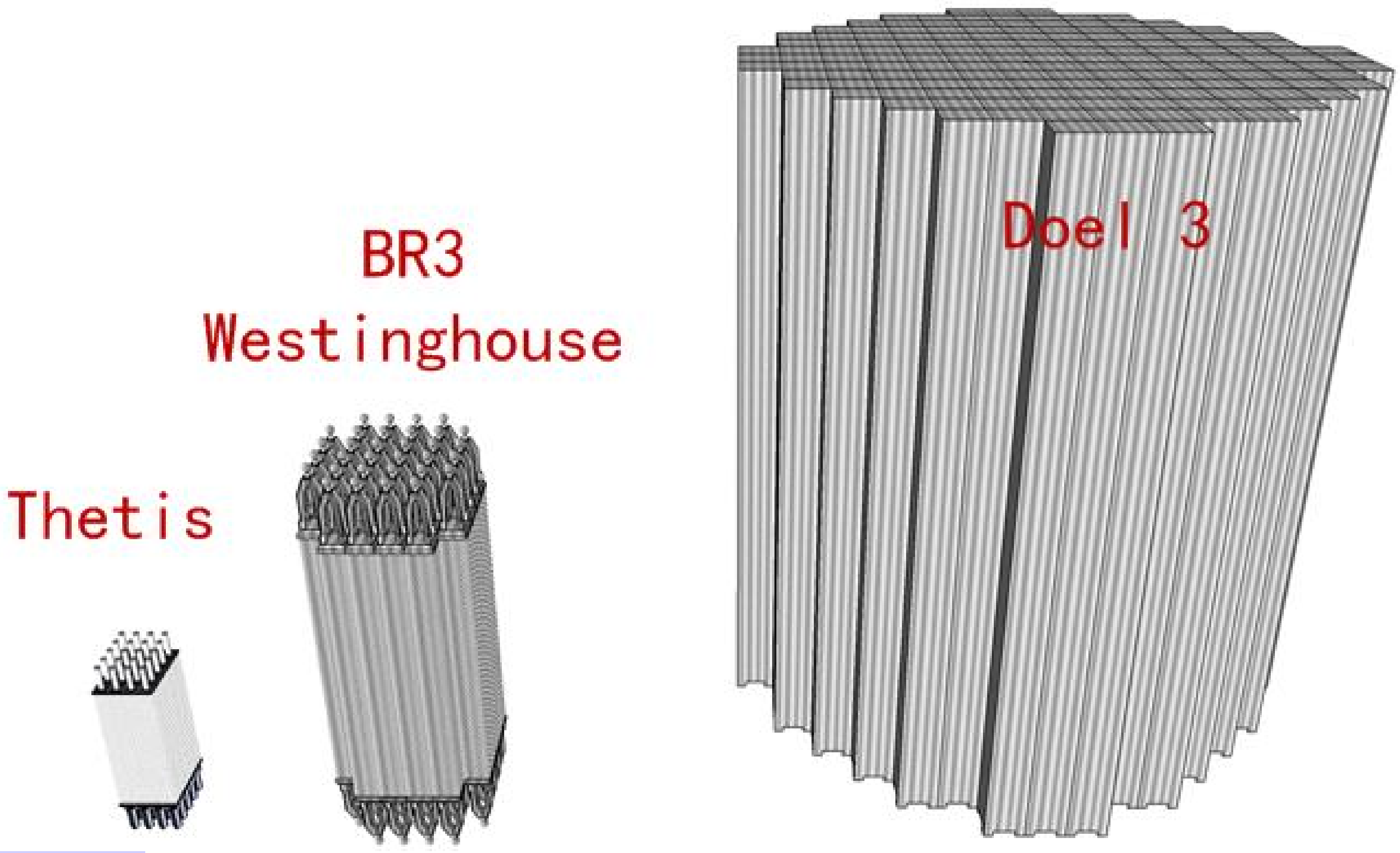
Case study 2: Thetis Research Reactor

- University Ghent, 3 km of the city centre
- In operations since 1967
- Final shut down in December 2003
- 25 fuel elements (LEU), light water, graphite moderated
- Power 150 kW (max. 250 kW)
- Open pool Ø 3 m, depth 7,5 m
- Main use:
    - Production of radioisotopes for medical applications;
    - Activation analyses

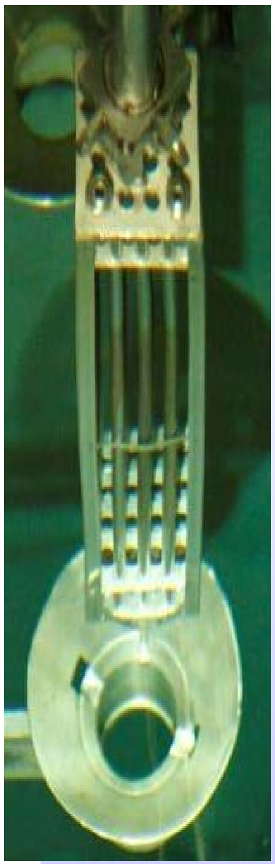




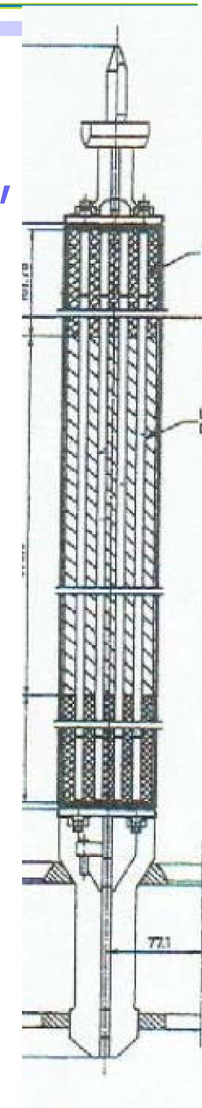
"Graded approach ..."



Evacuation of the spent fuel

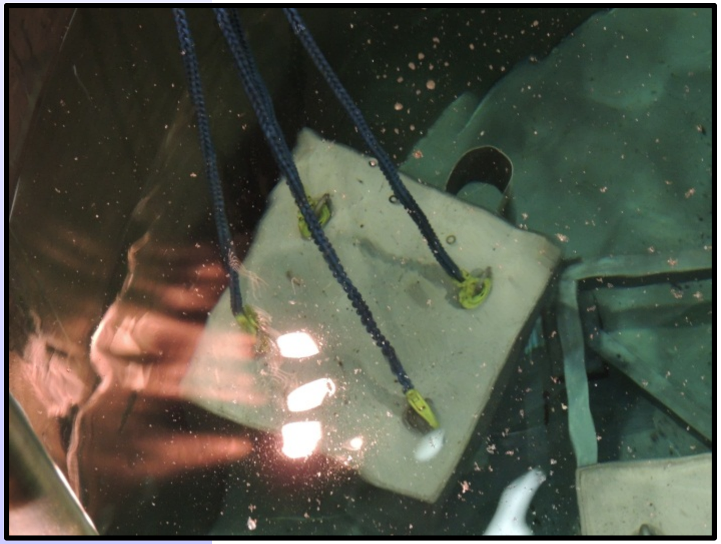


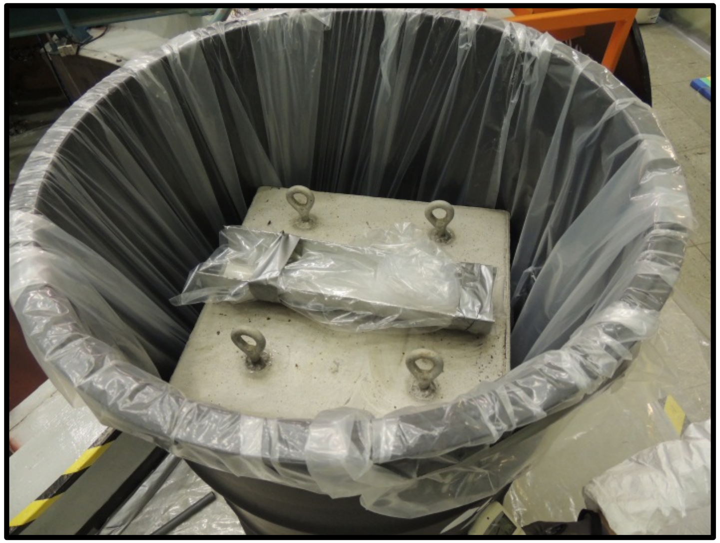
- 26 fuel elements (irradiated and fresh), 583 fuel rods
- Dose rate at the mid plane 1,5 Sv/h
- Evaluation criteria for the back-end solution:
  - Feasibility
  - Safety
  - Waste reduction
  - Total cost



Some quantitative data…

- Full coverage through ALARA procedure
- Total collective dose for the project:
  < 2 man.mSv
  - Fuel evacuation => 404 µSv.
  - Dismantling operations => 1,58 mSv





Case study 3
MOX production facility Belgonucléaire

- MOX fuel production facility on the site of Dessel from 1971 until 2006
- Production stopped and full stop of the facility on 15.08.2006
- 2006 : official demand to the FANC for the decommissionoing introduced
- 2008 : publication of the Royal Decree allowing for the dismantling
- 2009 : start of the operations under management of BN (training operators, foreign teams,..)
- 2010 à 2016 : dismantling
- 2017(?) : publication of the RD for removing BN from Class 1 Belgian Nuclear Installations

The main choices regarding general approach

No real formalized ALARA study BUT

- Use of well validated technologies
- Support from skilled external (German and Belgian) teams
- No cutting tools with fire hazard
- Development of specific training/tools
- **G**love **B**oxes dismantled on site (use of tent)
- RP objective : ~ 10 man.mSv / GB (constraint ?)

Dismantling operations

Glove Box placed
In a tent

Cutting of the GB

Tent is reduced

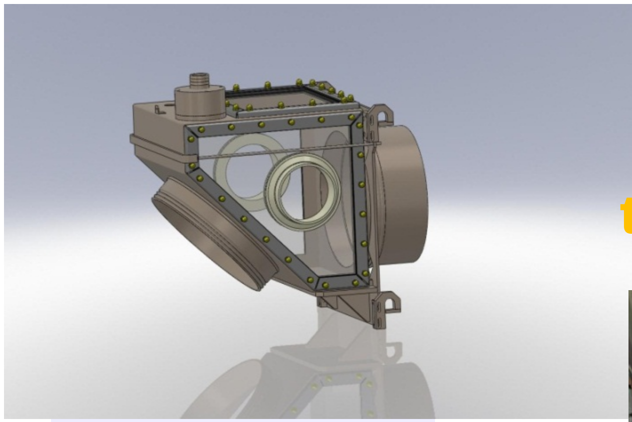
...and afterwards
rolled up

...for being finally transported to the “schredder GB”
in order to be cut into smaller circular pieces in such
a way that…

...they can fit with and be put
into drums for final removal

"Ad hoc" tools

From the concept …



through the box school

…to the controlled area

Some quantitative data…

	Dose Collective (h.mSv) (évaluation initiale : 10 mSv/tonne ou 1500-1800 h.mSv au total)	Quantité totale de déchets A3X (tonne) en fin d'année (planned :150 – 180)	Quantité de déchets A3X produit par année (tonne)	Dose Collective dose per tonne (h.mSv/tonne)
2009	121	10.8	10.8	11.2
2010	464	63.1	52.3	8.9
2011	364	114.1	51	7.1
2012	282	156.1	42	6.7
2013	269	189.7	33.6	8.0
Total	1500	-	-	Moyenne : 8.4

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Main conclusions

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General observations

- Dismantling = waste production

  (installation + a high quantity of new tools, shielding, ...)

- Dismantling was never planned during the design of the plant
- Mainly "one shot" operations
- Loss of knowledge ("be prepared for surprises ...!)
- Changing environment (location, shielding, teams,...)
- Impact from the "clearance of material" approach
- Poor accessibility (for the work, for the characterization ,...)
- Mutual transfer between R.R. and NR.R.

Lessons learnt on "ALARA Implementation"

The ALARA principle is an efficient approach for reducing the dose to the workforce

if : *Adequate dose follow-up* (operational, job/task dedicated,…)

Involvement of all stakeholders (operators, HP&S Dept., trade unions, workers, …)

Flexibility concerning regulatory management ("hot tests", draft procedures,…)

The ALARA principle is a good "catalyst" for the enhancement of the **global** safety culture

Lessons learnt on “ALARA Implementation” (cont’d)

- Impact of the decontamination of the primary circuit
  - = One of the first operations to be carried out.
  - Allows a strong reduction of the future doses of the workers.
- Added value of non radioactive mock-ups (scale 1/1).
  - Determination of optimal cutting parameters without exposition of workers.
  - Test of withdrawal and safety procedures,.
  - Training of personnel for the real intervention.

Remaining challenges ...?

- The ALARA principle should:

- be more considering the balance of risks between workforce, public and environment (management of waste, clearance)

- always be distinguished from the "good practices"

- be expanded to the ASARA principle

- *Use of dismantling info for new built*

Decommissioning Considerations for New Build

From "Decommissioning Activities at the OECD/NEA",Dr. Michael Siemann, Radiological Protection and Radioactive Waste Management ,OECD NEA 2014 North American ISOE Alara Symposium, 13 January 2014

- Decommissioning already benefits from optimal maintenance during operational phase

- Design should take into account the following aspects:

1. **Decommissioning activities**
   (dismantling, waste minimisation, facilities' inter-dependences)

2. **Site factors**
   (elimination of leakages to the environment, environmental data collection, infrastructure)

3. **Facilities and system design**
   (minimising infiltration of contamination, facilitating easy removal)

4. **Structural design**
   (access, space, modular systems, optimised shielding)

5. **Operational design**
   (early detect leakages, record keeping systems)

6. **Material design and waste management**
   (delineation of zones, segregation of materials, minimisation of activated material)

Coming soon : IAEA TECDOC

2014 : two IAEA technical meetings in Vienna:

- ***RPO's, dismantling projects managers,…***
- ***Regulatory Authorities***

"Practical Occupational Radiation Protection in Decommissioning of Nuclear Installations: Important Aspects for Management, Planning and Conduct"

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Studiecentrum voor Kernenergie
Centre d'Etude de l'Energie Nucléaire

Stichting van Openbaar Nut
Fondation d'Utilité Publique
Foundation of Public Utility

Registered Office: Avenue Herrmann-Debrouxlaan 40 – BE-1160 BRUSSEL
Operational Office: Boeretang 200 – BE-2400 MOL