CENTRE D'ÉTUDES SUR L'ÉVALUATION DE LA PROTECTION DANS LE DOMAINE NUCLÉAIRE

Waste management and radiation protection issues related to nuclear facilities decommissioning in France

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Content

- Decommissioning of nuclear facilities in France:
  - Current strategy,
  - Context,
  - Actors,

- Radioactive waste management in France:
  - Regulation,
  - Current situation,
  - Remaining issues.

- Radiation protection and decommissioning: what differs from operation?

Decommissioning of nuclear facilities in France
Current situation

- According to IAEA strategy, the French Nuclear Safety Authority (ASN) supports an immediate decommissioning strategy (future generation should not support dismantling activities, use current knowledge and skills, use existing funding for dismantling activities etc.).

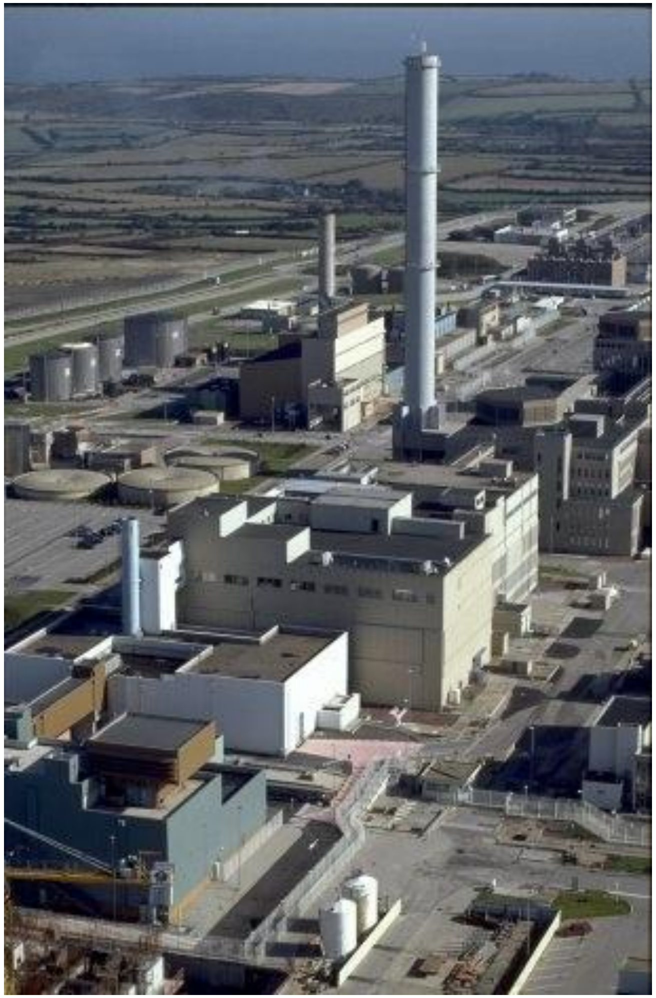
- But due to various issues - lack of founding, wastes storage capacities, etc. -, may re-oriented operators strategy (specially EDF).

- Many actors:
  - Operators: mainly EDF, AREVA, CEA,
  - ANDRA (Radioactive Waste Management Agency),
  - ASN (Nuclear Safety Authority),
  - IRSN (Public expert),
  - New companies in the nuclear field interested by the decommissioning business,
  - Public (NGOs, local elected people, etc.).

Decommissioning of nuclear facilities in France
Chooz A (305 MW_E PWR)

Decommissioning of nuclear facilities in France
Superphoenix (1200 MW_E FBR)

Decommissioning of nuclear facilities in France
UP2 400 (Reprocessing plant)



Decommissioning of nuclear facilities in France
Current situation

- As outlined, new undertakings with a lack of nuclear industry culture:
  - Need for safety culture training,
  - Need for RP culture training.

- Keep in mind that stakeholders' engagement is a crucial issue for successful dismantling program:
  - Definition of a shared goal for site end state (may influence waste volumes and thus costs).

- Finance (feedback from US):
  - Decommissioning costs of a NPP is increasing with time, now closed to 700 Mi.$ to 1000 Mi.$,
  - Decommissioning cost is increased with project length as 50 to 60% of the total costs are operational costs,
  - US operators are closing more and more NPP but put them in safe enclosure as funding is not sufficient.

Options for radioactive materials and wastes

<table>
<tr><th></th><th>Very short life $T_{1/2}$ < 100 days</th><th>Short life
$T_{1/2}$ < 30 years</th><th>Long life
$T_{1/2}$ > 30 years</th></tr>
<tr><td>Very low level
≈ 1 to 100 Bq/g</td><td rowspan="4">Management by radioactive decay</td><td colspan="2">Dedicated surface repository</td></tr>
<tr><td>Low level
≈ 0,1 to 100 kBq/g</td><td rowspan="2">Surface repository (CSA)</td><td>Dedicated shallow depth repository (under study)</td></tr>
<tr><td>Medium level
≈ 0,1 to 1 MBq/g</td><td rowspan="2">Under study (Bures laboratory – Deep geological repository)</td></tr>
<tr><td>High level
> 1 MBq/g</td><td></td></tr>
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Management of VLLW

- Dismantling of the 9 EDF facilities will generate over the next 20 years:
  - **500 tons of low and medium level / long life**,
  - **18 000 tons of graphite waste (low level / long life)**,
  - **41 000 tons of low and medium level / short life**,
  - **105 000 tons of very low level waste**,
  - **800 000 tons of conventional waste**.

- Need also to take into account dismantling activities from AREVA - key issue associated with George Besse 1, at least **150 000 tons of metal scrap (very low level waste)**.

- ANDRA VLLW storage facilities
  - Total capacity of 650 000 m3.
  - Storage costs from **500 to 1000 €.m-3**.
  - Already stored: 280 000 m3, end of 2014.
  - Not enough place for all our VLLW...

Clearance of radioactive materials in France

- There is no clearance level in the French regulations (conditional or unconditional) and this will not change with the implementation of the EC Directive 2013/59/Euratom.

- The French approach: the zoning concept: any material that is localized in an area where it may have been or is activated or contaminated is considered as a radioactive waste - without any measurement - and must be managed as such (most of the time stored in dedicated facilities):
  - Simple to implement,
  - But some materials are considered as radioactive while there are not…

- Several possibility to move forward:
  - Build new VLLW storage capacities,
  - Use conventional waste storage capacity,
  - But public acceptance in any case a key issue.

Management of other wastes

- Fuel storage is not an issue as irradiated fuel after cooling is sent to the reprocessing plant at La Hague - no intermediate spent fuel storage facility on site -. Vitrified waste will be stored in deep geological repository (CIGEO, estimated costs 25.10^{9} €…).

- Graphite (3H, 14C and Cl36) from gas cooled reactor is an issue as there is no storage facility so no possibility to move forward to reactor decommissioning.

Decommissioning of nuclear facilities
Occupational radiation protection

- When planning a decommissioning program, from an RP point of view, you must assess expected exposures before you start the activity:
  - Allow to appreciate radiation protection stakes for a dismantling activity and so to provide adequate resources (human, technical and financial) for radiation protection management.

- But this exposure assessment is very conservative for dismantling activities compared to what is observed for operating site:
  - Lack of feedback experience,
  - Lack of characterisation.

- As a consequence:
  - Wrong allocation of resources - loss of time and money -: **optimization is not reached**,
  - Abnormal evolution may not be detected as exposures remains quite lower than what was planned: **optimization is not reached**,
  - How to convince the Authority that you control you activity?

Occupational radiation protection and dismantling of nuclear facilities

- As a consequence:
  - Wrong allocation of resources - loss of time and money -,
  - Abnormal evolution may not be detected as exposures remains quite lower than what was planned: optimization is not reached,
  - How to convince the Authority that you control you activity?

- Ways to improve RP management for decommissioning activities:
  - Radiological characterisation,
  - Develop a radiation protection culture among new players,
  - Knowledge management during operation,
  - International benchmarking activities (Germany, USA, etc.).

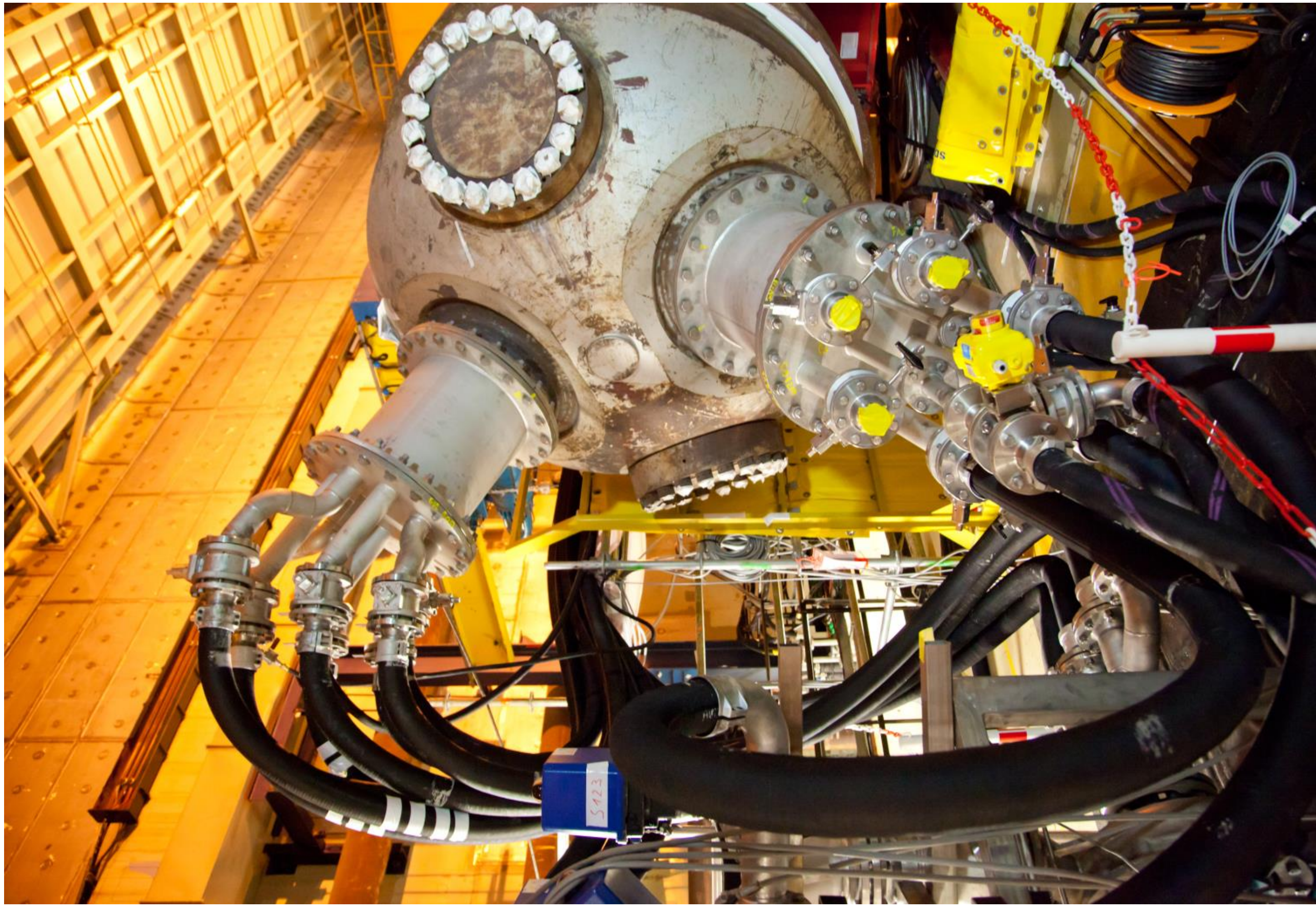
Radiation Protection - Feedback from Chooz A

- Key characteristics:
  - Westinghouse PWR, 305 MW_E, shut down in 1991,
  - Alpha contamination,
  - Built in a cavern under a hill (issue with radon progeny and alpha measurement).

- Currently preparing reactor vessel cutting (Westinghouse).

- In order to improve radiation protection management for the future dismantling project (EDF currently operate 58 PWR among which Fessenheim), need to draw lessons learnt from Chooz A.

Radiation Protection - Feedback from Chooz A



Radiation Protection - Feedback from Chooz A

- **Key issue 1: characterisation of the facility:**
  - The most important stage to ensure the success of the overall decommissioning project. As far as possible: favour characterisation rather than modelling,
  - Detailed areas mapping - several dose rate measurement per room/location -,
  - Several smears in all rooms - 3 or 4 for 10 to 20 m^2 -,
  - Sampling all circuits, especially those in contact with primary fluid,
  - Pictures and 3D mapping,
  - Gamma camera - especially for hot spots characterisation -,
  - Lead and asbestos must be also taken into account when characterising the facility,
  - Need for a detailed description of components to be dismantled (thickness and nature of steel, etc.).

Radiation Protection - Feedback from Chooz A

- **Key issue 2: workers training:**
  - Need to spend some time on the spot to get skills (time) and develop the so-called RP culture,
  - Dismantling ≠ operation and training must be adapted,
  - Do not forget industrial safety.

- **Key issue 3: management of α risk:**
  - 730 Bq of 241Am intake leads to a 20 mSv engaged dose…
  - But avoid 'over protection syndrom' regarding α contamination,
  - Try to be flexible and pragmatic,
  - Adapt collective as well as individual protection action to real expected risk,
  - Need for trained workers (dressing/undressing a key issue),
  - As far as feasible: full system chemical decontamination before starting work (see German feedback).