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Deciding on Decommissioning Strategy

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Deciding on Decommissioning Strategy

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Content

- About decommissioning (definition and goals)
- Decommissioning strategies
- Section of optimal strategy
- Planning and implementing decommissioning
- IAEA role and activities

Decommissioning

- Decommissioning definition:
  - The administrative and technical actions taken to allow the removal of some or all of the regulatory controls from a nuclear facility
- Decommissioning objectives:
  - to place nuclear facilities that have reached the end of their useful lives in such a condition that they pose no unacceptable risks to the public, to workers or to the environment,
  - to reuse facilities and sites for new purposes

Decommissioning Strategies

- **Three main decommissioning strategies:**
  - Immediate dismantling (as soon as facility cease to operate)
  - Deferred dismantling: Safe enclosure (for several decades) → dismantling
  - Entombment (long term) → facility converted into a form of waste disposal

Immediate dismantling

- Full decommissioning to the final state in a continuous manner soon after the end of operation
- Starting with removal of spent fuel and other highly toxic materials (post-operational clean-out)
- Advantages:
  - Early release of site for future uses
  - Availability of operating staff knowledge and labour
  - Avoiding surveillance and maintenance costs over an extended period
- Constraints:
  - Availability of waste disposal capabilities or interim storage arrangements
  - Suitable technologies (high radiation fields!)

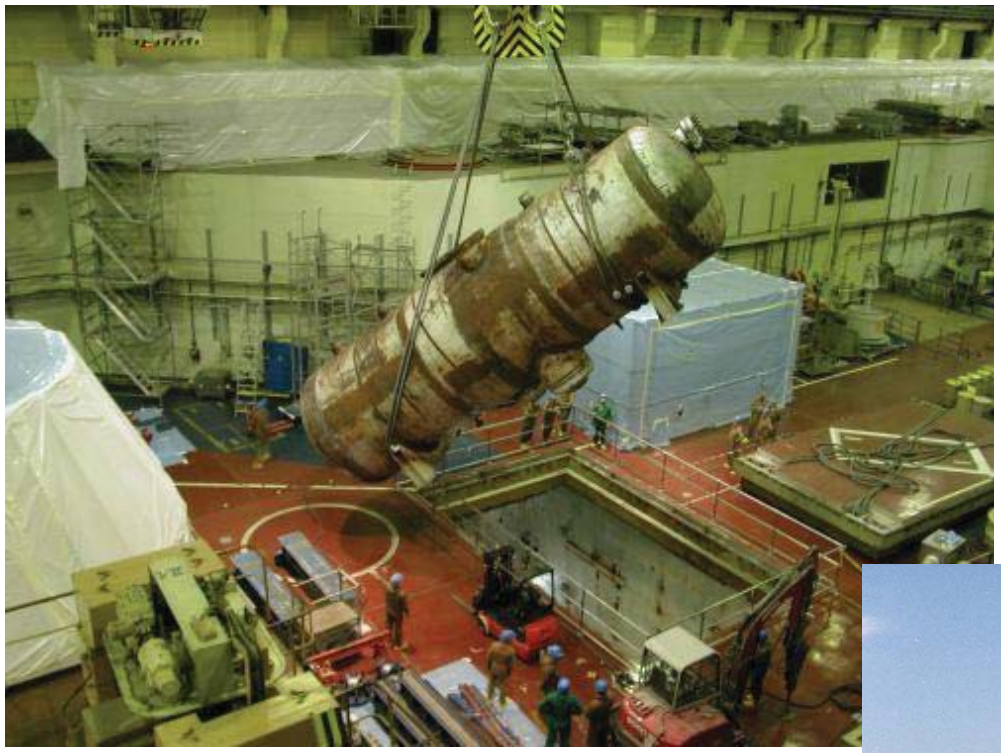
Deferred dismantling

- It includes at least one extended period of surveillance and maintenance of the facility (up to 100 years)
  - Starting with post-operational clean-out and/or removal of spent fuel
  - Followed by activities to put the facility in optimal state for surveillance and maintenance
- Advantages:
  - Use of radioactive decay to reduce radiation dose to workers
  - Less waste of higher activity or waiting for disposal solution
  - Waiting for sufficient funds
- Disadvantages:
  - Long-term facility maintenance and security costs
  - Risk of loss of knowledge
  - Restriction on use of the site

Entombment

- Leave the heart of the facility *in situ*, usually covered over by earth and/or concrete – treating the site as disposal facility
  - Fuel removal and other materials for recycle and reuse still takes place
  - Limited dismantling and modification to provide optimal entombment
- Advantages:
  - Reduced volumes of waste
  - Lower workload and costs
- Disadvantages:
  - Extended environmental monitoring programme necessary
  - Stakeholder concerns over long-term implications

Examples of Immediate Dismantling



Immediate dismantling of NPPs in Greifswald, Germany

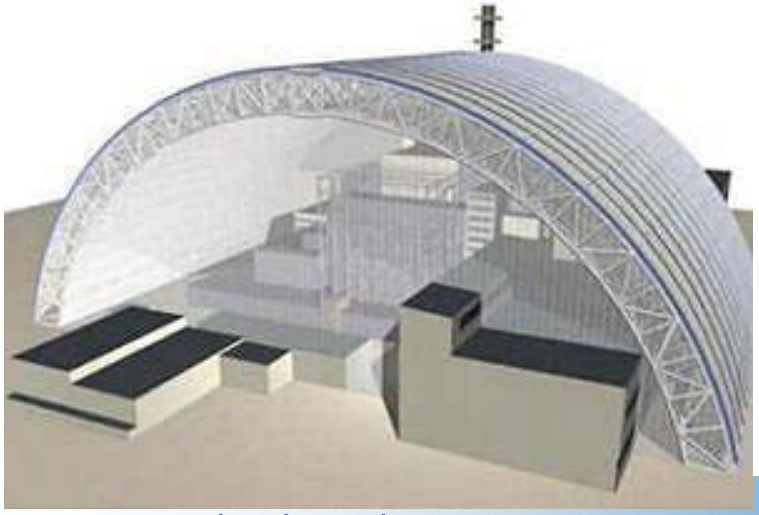
Immediate dismantling of V-1 NPP in Bohunice, Slovak Republic

Example of Deferred Dismantling

Safe enclosure of Vandellos I NPP in Spain (20 years or more)

Example of Entombment

New Sarcophagus for 4th unit of Chernobyl NPP



Selection of strategy

- Factors that influence selection of strategy:
  - National policy and regulatory requirements on decommissioning
  - Availability of financial resources
  - Cost estimates
  - Decommissioning technologies and equipment
  - Spent fuel and waste issue
  - Safety and security
  - Regulatory aspects
  - Social and economic impacts
  - Stakeholder consideration
  - Facility specific issues

Selection of strategy

- In selecting preferred strategy all relevant factors need to be identified and considered in a systematic and auditable way
  - In more complex situations a multi-variant decision process using weighting and scoring system may be useful
  - Results should be tested for sensitivity to changes in any of initial assumption
  - Risk of regulatory changes or unexpected plant conditions should be considered (strategies that do not foreclose later changes of approach!)

Planning for Decommissioning

- Successful decommissioning depends on careful and organized planning
- Preliminary plans:
  - IAEA recommends to prepare initial decommissioning plan for each facility and before it is put in operation
  - regular review and update during the operation necessary
  - important also to enable adequate financial arrangements
- Final decommissioning plans
  - First detailed plan should be prepared before the end of facility operations
  - The extent, content and degree of detail in the decommissioning plan depends on the complexity and hazard potential of the installation

Financial provisions

- Adequate financial resources are prerequisite for successful decommissioning
- Early decommissioning plans and cost estimates are necessary
  - selection of methodology for cost estimation
  - Periodic cost updates
- Funding schemes vary from country to country
  - Funds accumulated over the entire lifetime of the facility
  - Funds collected over shorter period
  - Operator required to make a down payment to get the first operating licence
- Conservative investment strategy

Start of Decommissioning

- Start of decommissioning not necessarily linked to spent fuel removal, but it is recommended
- Decommissioning-related activities should start well before final shutdown (planning, preparation of licensing documentation, pre-decommissioning characterization etc.);
- Transition from operation to decommissioning has to be used for careful preparation of decommissioning activities (see IAEA TRS No. 420)
- Decommissioning license shall be issued by national nuclear regulator

Active Phase of Decommissioning

- Active phase includes the following technical activities:
  - Decontamination of equipment and building surfaces;
  - Dismantling of nuclear facility technology;
  - Demolition of buildings and structures;
  - Waste characterization, segregation, treatment, storage, transportation and disposal;
  - Environmental remediation related to decommissioning of nuclear facility;
  - Site clearance before the license termination

Decommissioning Technologies

- Many decommissioning technologies available (also commercially)
- Remotely operated and robotics technologies are used for work in environment with high radiation and/or physically not accessible for staff
- Innovative or substantially modified techniques are needed in case of prototype nuclear facilities or facilities shut-down after an accident
- R&D on decommissioning technologies is / will be needed in the most difficult cases (Chernobyl, Fukushima)

Robotic arm Maestro, France

Manipulator DENAR-41, Slovakia

Final Decommissioning Phase

- Decontamination and dismantling activities completed
- All radioactive material removed
- Final survey performed
- Final decommissioning report prepared
- Application for license termination issued (it is necessary to demonstrate to the authorities that no radioactivity above prescribed levels is left)
- Post-decommissioning activities:
  - Non-nuclear dismantling (e.g. remaining buildings),
  - Landscaping,
  - Site reuse / redevelopment

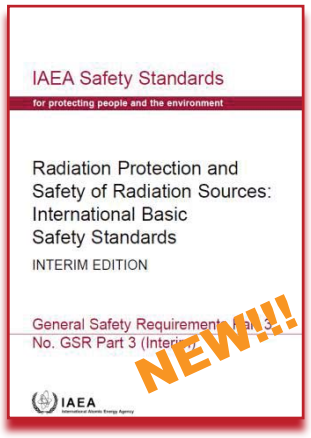
Current Status

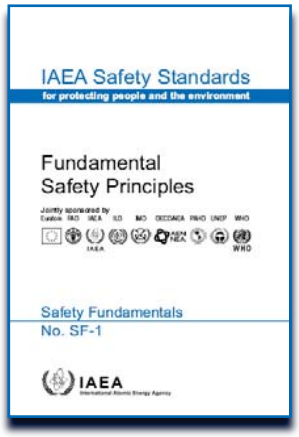
- Current status of decommissioning worldwide:
  - 16 power reactors were shut-downed and fully dismantled;
  - 50 power reactors are in process of being dismantled;
  - 49 power reactors are being kept in safe enclosure mode;
  - 3 power reactors were entombed;
  - 6 power reactors do not yet have specified decommissioning strategies
- More than 400 research reactors already decommissioned or in process of dismantling

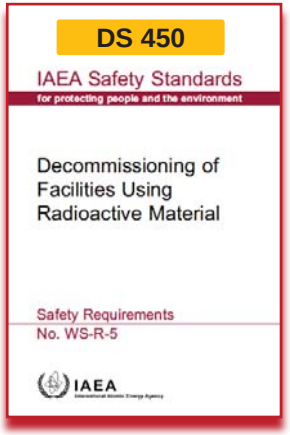
IAEA activities

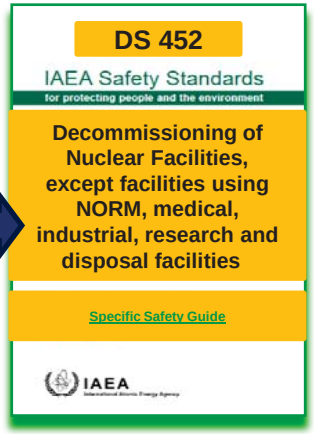
- Safety Standards and guides for harmonization of safety approaches
- Facilitating international cooperation, information exchange and capacity building:
  - Technical reports and publications
  - Coordinated research projects
  - Networks
  - Databases
  - Training courses and eLearning
  - Conferences and Symposia
- Technical assistance to Member States (TC projects)
- Review services

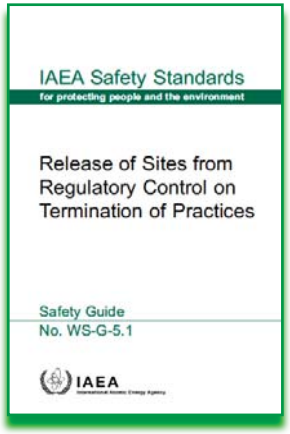
WSS on Decommissioning

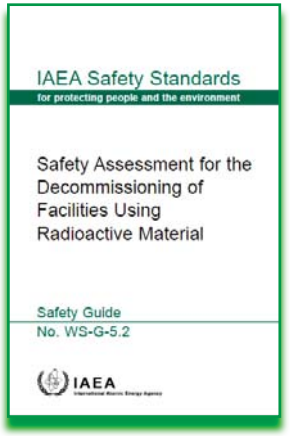












Technical reports

IDN - Decommissioning Network

- IDN – International Decommissioning Network
  - a tool to address the needs of Member States through thematic and strategically focused approaches
  - A tool to encourage and facilitate sharing of information between practitioners, i.e. between and among those with extensive decommissioning experience and those seeking to learn from this experience
  - A tool to promote application of "best practices" in decommissioning technology, planning, project management, and the management of nuclear wastes
- Documents, meetings, training events, workshops, video demonstrations
- CONNECT a collaboration platform hosted by the IAEA - a gateway for interconnecting IAEA Networks

International Experts' Meeting

- IEM Decommissioning and Remediation after a Nuclear Accident will be held from 28 January to 1 February 2013 in Vienna
- IEM will focus on relevant decommissioning and remediation technical aspects