Long term transition phase between power operation and decommissioning in German NPP

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Decommissioning Experience in Germany

Past and current decommissioning projects of **prototype or commercial reactors**

- Total: 19
- Removed: 3
- Under dismantling: 14
- Safe enclosure: 2
- Reactor types:
  - PWR
  - BWR
  - Fast breeder
  - High temperature gas cooled
  - Heavy water gas cooled

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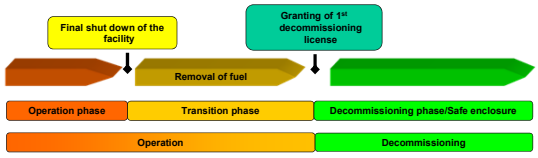
Basic Requirements for Decommissioning

Regulation of decommissioning in Germany

- § 7 (3) of the German Atomic Energy Act

  The decommissioning of an installation […] as well as the safe confinement of an installation, or the dismantling of an installation or of parts thereof shall require a license […].

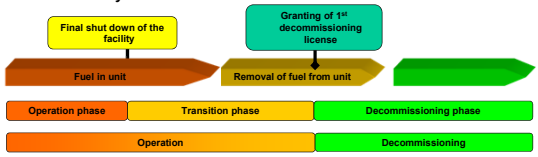
Lifetime of a facility



Long term transition phase in German NPP since 2011 /1/

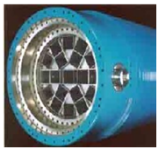
- After the accident in Fukushima 8 German NPP units finally shut down in 2011 (no permission for power production)
- Units are in so-called „post operation phase“ with fuel on unit
- First applications for decommissioning submitted
- Intention to start decommissioning phase with fuel on unit

Lifetime of a facility



Long term transition phase in German NPP since 2011 /2/

- Differences to “normal” final shutdown:
  - No time for planning and preparation of final shutdown
    - ➢ prolonged duration of „post-operation phase“
  - Currently, transport casks are not available sufficiently
    - ➢ Fuel stays in units for years



Fuel in unit	Protection goals
Compliance with the 3 fundamental protection goals necessary	Control of reactivity Cooling of the fuel elements Confinement of the radioactive materials

Operational changes and corresponding regulations /1/

- Examples of important changes
  - Modified operation mode of systems
  - Long term decommissioning of single trains of redundant safety relevant systems
  - Modified operational management, e.g.:

Modifications in operational management	Relevant regulations
Modified maintenance and inspection concept, e.g. scope and frequency of recurrent tests	Maintenance regulation in the operating manual based on general requirement in KTA safety standards
Modified staffing of shifts – minimum staffing and qualification	Personnel organization and shift staffing defined in the operating manual based on general requirement in KTA safety standards and in directives on qualification and training of the personnel
Modified shift training concept	Directives on qualification and training of the personnel

Operational changes and corresponding regulations /2/

- All existing national regulations remain valid for units in post operation phase
  - Regulation is based on power operation and “short” shutdown conditions
- Most operational changes were made in the frame of the regulatory supervision process by the state authorities
- Some changes were made with adapted national regulation
  - Qualification and training of the personnel

Operational changes and corresponding regulations /3/

- Requirements regarding the necessary qualification for NPP personal are defined in several directives
  - Directive for the **Proof of the Technical Qualification** of NPP personnel
    - Qualification standards for shift personnel and important management staff including necessary pre-qualification
    - Minimum shift crew
    - Necessary examinations
  - Directive for **Maintaining of Technical Qualification** of responsible NPP personnel
    - Necessary efforts (simulator trainings, theoretic training sessions etc.) to maintain the qualification
    - Relevant both for shift- and management-staff
  - Directive for the **Examination Content** for NPP personnel
    - Detailed description of the examination content

Operational changes and corresponding regulations /4/

- Amendments were made to these three directives to reflect the special situation of the units in post operation phase
  - Necessary qualification of shift crew has been reduced
    - No further requirement for a shift leader with university degree which is permanently onsite
    - Former deputy shift leader may act as shift leader
  - Reduced examination content for newly qualified staff for units in post operation phase
    - Examination content is limited to the still relevant aspects (radiation protection, systems for spent fuel pool cooling, criticality within the spent fuel (“fresh” elements!), events which may affect the spent fuel pool etc.)
    - Special courses with the limited examination content were established by the German nuclear training center
  - Extent of the necessary efforts to maintain the qualification has been reduced

Operating experience in post-operation phase

- On behalf of BMUB GRS evaluates in depth licensee event reports from German NPP
- Finding: post-operation phase shows new failure mechanisms
- Most new failure mechanisms are related to modified operation mode of systems, e.g.
  - Corrosion effects in heat exchangers for residual heat removal:
    - rarely used due to low residual heat
    - standing cooling medium in system increases corrosion
  - Failures in electrical systems (including emergency power generation)
    - Reduced electrical loads
    - Signal sequences - timing problems

Regulations relevant for decommissioning /1/ (excerpt)

- BMUB Publications
  - Decommissioning Guide
  - Guideline relating to Emission and Immission Monitoring of Nuclear Facilities (REI)
  - Guideline for Radiation Protection during Inspection, Maintenance, Repair and Dismantling of NPPs (IWRS II)
- Advisory body ESK recommendations: Guideline on Decommissioning
- Certain KTA Technical Rules

- Existing regulations partly contain unspecific requirements, like
  - KTA rule is applicable in relevant parts
  - Personnel organization has to be adapted appropriately

Regulations relevant for decommissioning /2/

The decommissioning guide

- Objective:
  - Harmonize the procedures among all state (Länder) authorities
    - Comprehensive collection of existing requirements and recommendations on the decommissioning of nuclear facilities in Germany with a strong focus on procedural licensing and supervisory aspects
    - Represents good practice in Germany
- Content (excerpt)
  - Aspects of decommissioning planning, licensing and supervision
  - Aspects to be considered during the safety assessment
  - Applicability of BMUB publications and KTA safety standards

Summary

- Decommissioning, safe confinement and dismantling of an NPP in Germany requires a license
- Few regulatory documents exist specifically for the safe decommissioning of NPPs
- Few adapted regulatory requirements for long-term post-operation phase
  - States decide about modified requirements in normal regulatory process case by case
- GRS is preparing a research project about specific post-operation issues
  - Assessment of organizational changes
  - Internal and external impacts
  - Probabilistic analysis of specific event sequences

Removed NPP Niederaichbach

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Thank you for your attention!