Regulatory Requirements for Radiation Protection in Decommissioning in Germany

18. EAN Workshop ALARA for Decommissioning and Site Remediation

Marcoule, France, 11 – 13 March 2019

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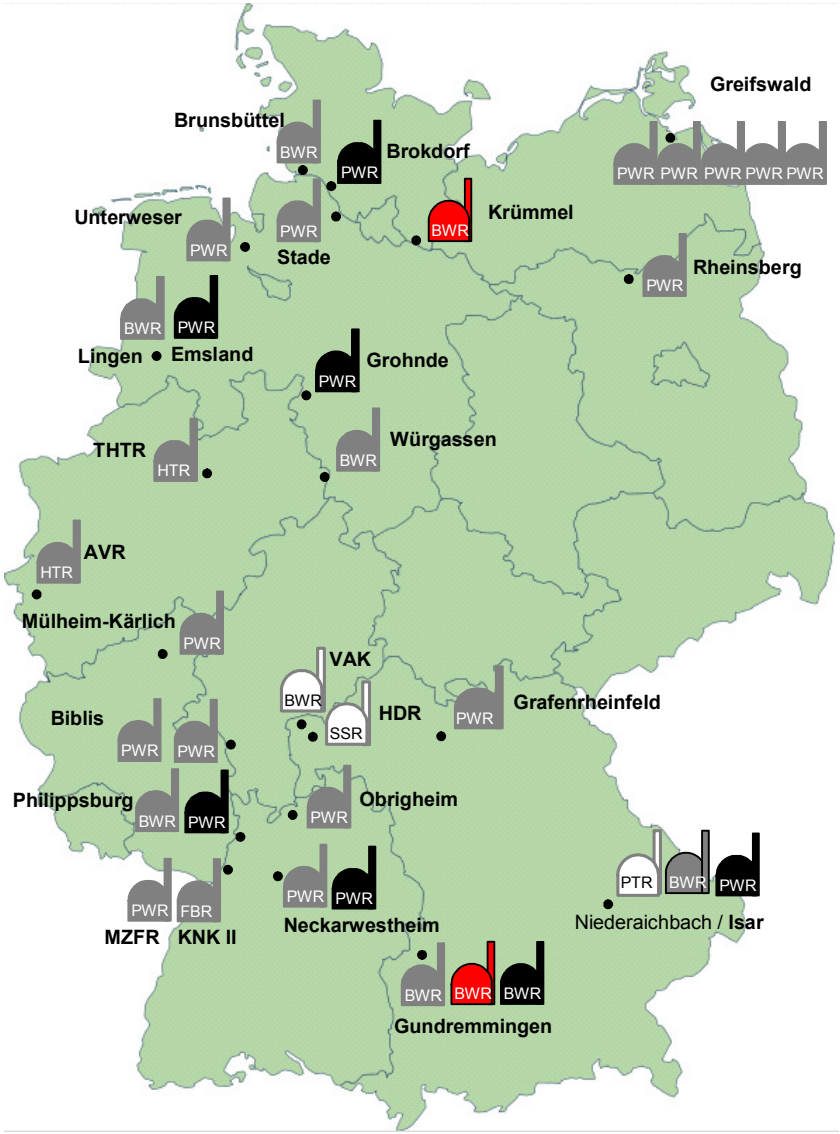
Federal Office
for the Safety of
Nuclear Waste Management

Nuclear Power Phase Out

- In 2011 the German legislator decided to **phase out** the use of nuclear power for the commercial generation of electricity in a **stepwise process** by the end of 2022 at the latest
- Shut down NPPs will be decommissioned with the strategy of **immediate dismantling**
- Germany gained **experience** in nuclear decommissioning since the nineteen-seventies

Overview Status of NPPs in Germany:



in operation

shut down permanently,
application for decommissioning

in decommissioning

decommissioning finished

Status: January 2019

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Overview: Nuclear Facilities in Germany

	Nuclear Power Plants	Research Reactors	Nuclear Fuel Cycle Facilities
In operation	7	7	3
Shut down permanently	2	3	-
In Decommissioning	24	7	2
Decommissioning finished	3	29	9

Status: January 2019

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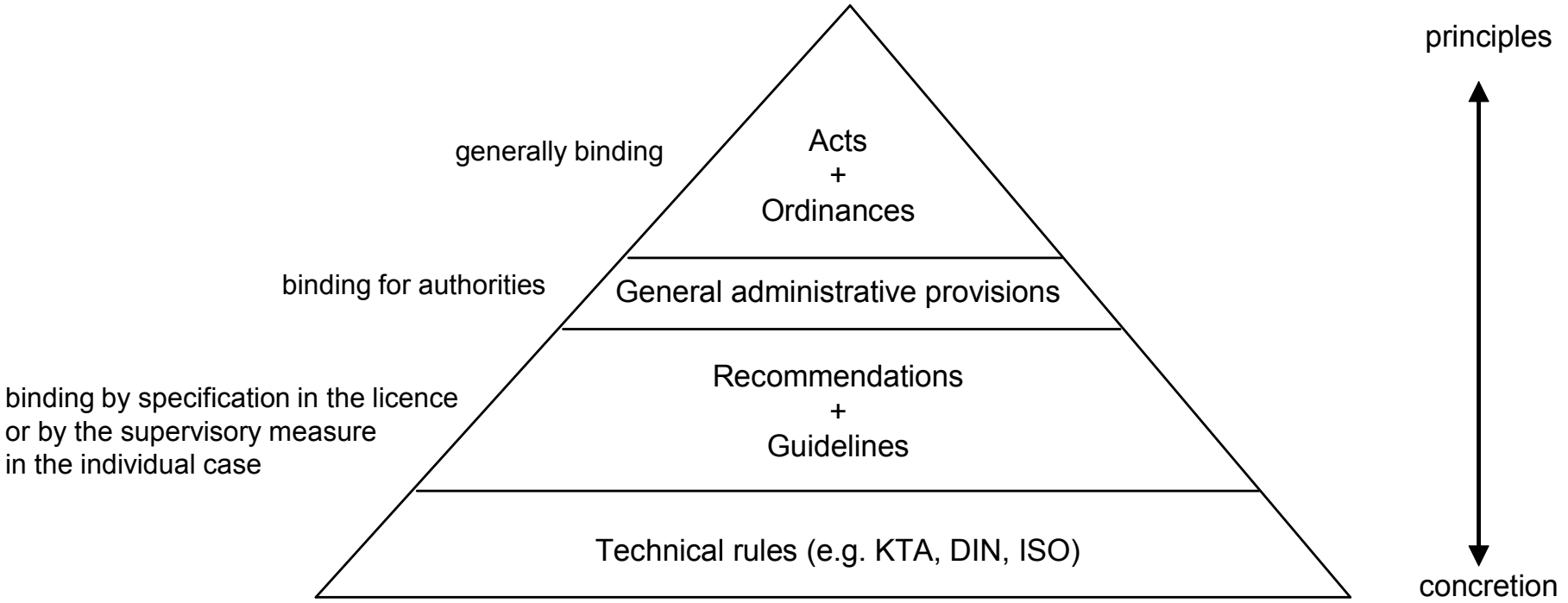
Regulatory Framework



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Relevant For Radiation Protection:

Radiation Protection Act (StrlSchG) of 27 June 2017

- Radiation Protection Principles
- Dose limits for workers and public

Radiation Protection Ordinance (StrlSchV), in force coming 31. December 2018:

- Determines the technical and operational measures and procedures for protection against damage from ionizing radiation
- Regulates the clearance (administrative act effecting the release from nuclear supervision)

Radiation Protection Principles

§§ 6 – 9 Radiation Protection Act:

- Justification of practice that might cause exposures or contamination
- Avoiding unnecessary exposures or contamination
- Obligation to reduce exposures or contamination below the dose limits **as low as possible**
- No excess of dose limits

Dose Limits for Workers and Public Valid for Decommissioning (and Operation)

Workers (§§ 77-78 Radiation Protection Act):

- 400 Millisievert lifetime effective dose summarised
- 20 Millisievert effective dose per calendar year (adults)

Public (§ 80 and § 104 Radiation Protection Act):

- 1 Millisievert effective dose per calendar year, summarised all expositions
- Dose limit in case of accidental release: 50 Millisievert

Necessity for Dose Optimization (StrlSchV)

Dose Guiding Value (§ 1 (5) StrlSchV):

- Highest dose to be taken into account when planning and optimising protective measures for people in scheduled exposure situations
- Radiation protection supervisor has to take care, that the dose guiding values are documented and preserved after completion of activity (§ 72 StrlSchV)

Other protective measures (§ 75 StrlSchV):

- Protection against external and internal exposure shall be preferential by structural and technical equipment or by appropriate procedures
- Open radioactive materials on workplaces shall be only present as long as and in activities required for the work procedure

Necessity for Dose Optimization (StrlSchV)

Radiation protection directive (§ 45 StrlSchV):

- A radiation protection directive shall be issued ruling the fundamental procedures required for radiation protection
- Radiation protection directive can be part of the operating instructions

Radiation protection areas (§ 52 StrlSchV):

- Supervised area: e.g. more than 1 Millisievert annual effective dose (no conrolled area)
- Controlled area: e.g. more than 6 Millisievert annual effective dose
- Exclusion area: more than 3 Millisievert per hour (part of controlled area)

Guiding Documents Concerning Radiation Protection

"**Guide to the Decommissioning, the Safe Enclosure and the Dismantling of Facilities […]**" (Decommissioning Guide), developed by representatives of the Federal Government (BMU) and of the Länder authorities, republished 2016

Recommendation of the Nuclear Waste Management Commission (ESK): "**Guidelines for the Decommissioning of Nuclear Facilities**", republished 2015

Guideline for the protection against radiation of personnel during the execution of maintenance work, modification, disposal and the **dismantling** in nuclear installations and facilities Part II (IWRS II) of 17 January 2005:

- Radiation protection measures to be taken during the operation or decommissioning of an installation or facility

General Statements on Radiation Protection in Decommissioning Planning

For the preparation of decommissioning, requirement 3.11 (7) of the Safety Requirements For Nuclear Power Plants stipulates:

- “The condition of nuclear power plants shall be such that they **can be decommissioned in compliance with the radiation protection regulations** […].

The operating licenses for nuclear power plants generally stipulate a **periodic review** of the decommissioning concept, e.g. regarding

- Data relevant for radiation protection (dose rate atlas and contamination atlas) and the consequences of special events which are relevant for the decommissioning procedure.

In Advance of Decommissioning

Reporting of radiation protection aspects required:

- **Article 37 of the Euratom Treaty** stipulates that e.g. for dismantling of nuclear reactors, “general data” shall be submitted to the European Commission from which potential (radiological) impacts on the territory of other states of the European Union can be determined.

- **Safety Report** as central part of the application documents describes consequences with a view to nuclear safety and radiation protection for workforce and public

- **Environmental Impact Assessment Report** includes aspects of radiation protection for the public

Adaptions to Decommissioning Conditions

The radiation protection measures are to be adapted to the requirements and changed framework conditions of dismantling:

- Facility changes during dismantling.
- Appearance of aerosols due to opening and segregation of components.
- Changed nuclide composition compared to power operation.
- Longer times of stay of personnel in areas with open contamination compared to power operation.
- Direct radiation is to be determined for each dismantling area.
- Use of shielding devices and installations for remote-controlled dismantling and handling are to be provided in order to reduce the radiation exposure of personnel by direct radiation.

Decommissioning Strategy and Radiation Protection

Immediate dismantling of shut down NPPs is the preferred decommissioning strategy by law (§ 7 (3) Atomic Energy Act)

- In individual cases the regulator can approve temporary exceptions from this rule for parts of the facility, if this is necessary for radiation protection reasons.

Decay storage of unsegmented large components combines the advantages of immediate dismantling with the reduction of dose rates by radioactive decay when the components are segmented later.

Decay storage of unsegmented steam generators and RPVs at Interim Storage Facility Greifswald (ZLN)
Source: EWN GmbH

Definition of Decontamination Techniques

Aspect of radiation protection

- Avoidance of unnecessary radiation exposure
- Dose reduction
- Removal of contamination to increase the admissible time individuals can stay in working areas or to achieve appropriate conditions for carrying out decommissioning work

Other aspects have to be considered as well:

- Utilisation of radioactive substances and parts of the facility
- Reduce waste volumens
- Minimisation of secondary waste

➡ **Optimization!**

Definition of Dismantling Techniques

Aspect of radiation protection

- Type and amount of activity present
- Possibility of aerosol formation
- Contamination hazard
- Enclosure of mobile activity
- Measures for limiting the individual and collective dose (e.g. availability of remote controlled techniques)

Other aspects have to be considered as well:

- Tecnological task (material, size of component, surroundings, accessibility)
- Intended further treatment and utilisation
- Secondary waste generated

➡ **Optimization!**

Work Permit Procedures (IWRS II)

Purpose:

- Requirements for determination and implementation of radiation protection measurs within the work permit procedure
- Proof and evaluation of measures to optimise radiation protection within the supervisory procedure

Defines dose-intensive activities:

- more than 6 Millisievert individual dose or more than 25 Millisievert collective dose

Defines unfavourable radiological conditions:

- Unfixed surfacecontamination in working areas above a certain level
- Possibility of radionuclide incorporation above a certain level
- Strongly crowded room conditions in conjunction with dose rates > 3 Millisievert per hour and an expected individual dose of more than 1 Millisievert for the activity

Work Permit Procedures (IWRS II)

General demands:

- Keep number of involved workers as low as possible
- Consider radiation protection early during planning of the work
- Prepare a summary of individual- and collective doses occured for last years dose-intensive activities
- Analyse potential for further radiation protection measures
- Establish criteria for applicarion of radiation protection measures
- For components with high dose rates it is advisible to prove techniques on inactive models (mock-up)
- Observe radiation protection relevant interdependencies of works in order to bundle radiation protection activities (or separate them)
- Establish a radiological monitoring program

Work Permit Procedures (IWRS II)

Schematic diagram for planning of dismantling works:

Routinely radiation protection procedure (no dose-intensive activity and no unfavourable conditions)

Otherwise: Specific radiation protection procedure

Additional demands:

- Detailed planning of work preparation under early involvement of the radiation protection officer (coordinated work permit), including clarification of radiological boundary conditions, determination of techniques and required qualification of workers
- Preparation of a plan for registration of activity-related radiation exposures
- Evaluation of radiation protection measures in view of future activities (feedback of experiences)

Experiences and Recommendations

[Source: Final Report (GRS-A-3944) for research project 3615S22301]

- Dismantling of NPPs can be carried out with lower annual collective doses compared to the doses during operation.
- System decomtamination during post operational phase improves (decreases) the level of dose rate in the facility.
- Removal of unsegmented large components allows segmentation and processing under optimised conditions. Dose reductions depend on the single case (e.g. use of remote techniques).
- Potentials for dose reduction in decommissioning need further investigations (more activity-related exposure data needed).

Thank You for Your Attention!

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