

Radiation Protection during Decommissioning of Nuclear Facilities – Experiences and Challenges

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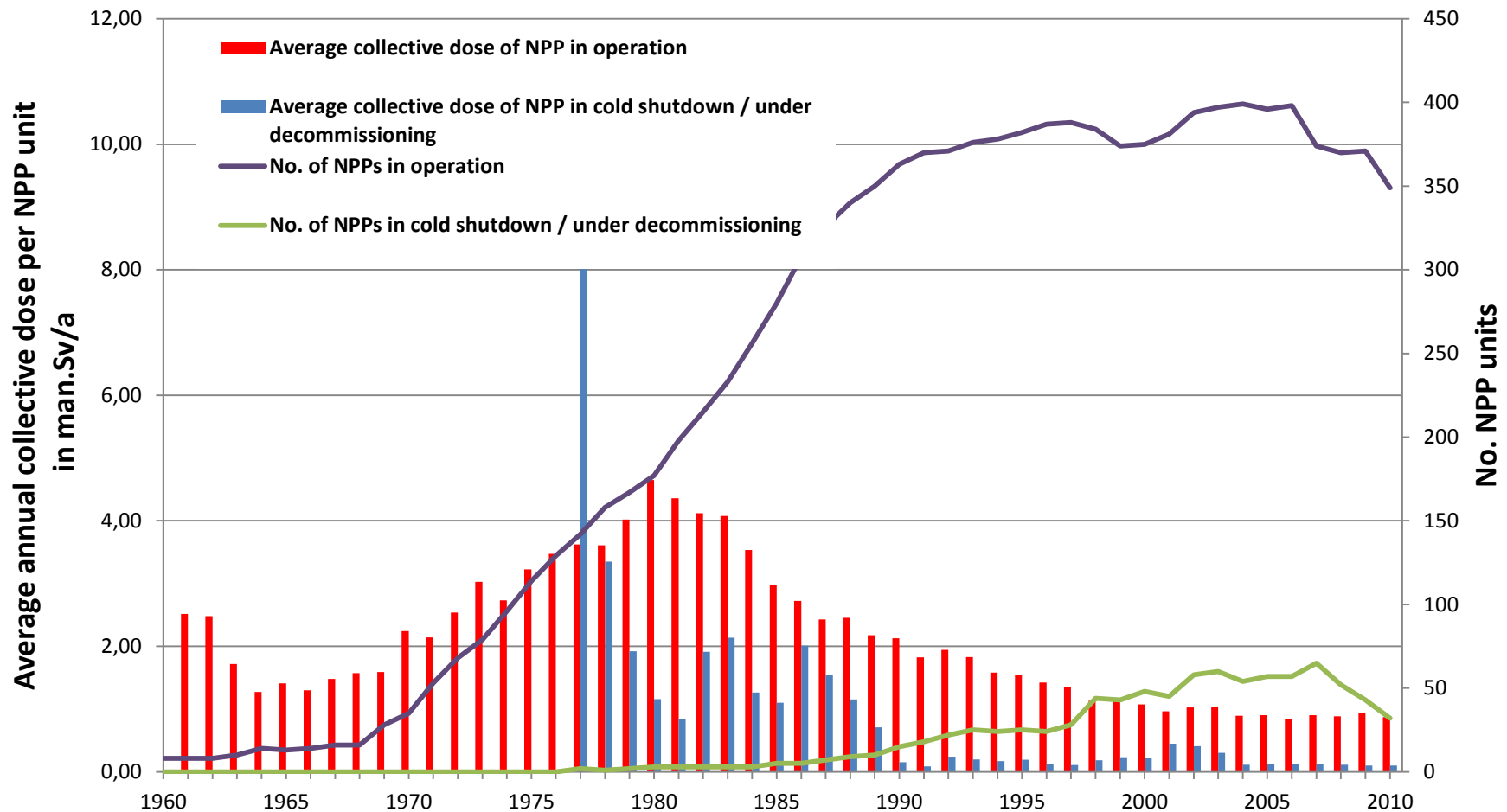
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Content

- Overview on Occupational Exposure during Decommissioning of NPPs
- “Daily” Radiation Protection Challenges during Decommissioning
- Selected Experiences from Past and Current Projects
- Conclusions and “Future” Radiation Protection Challenges

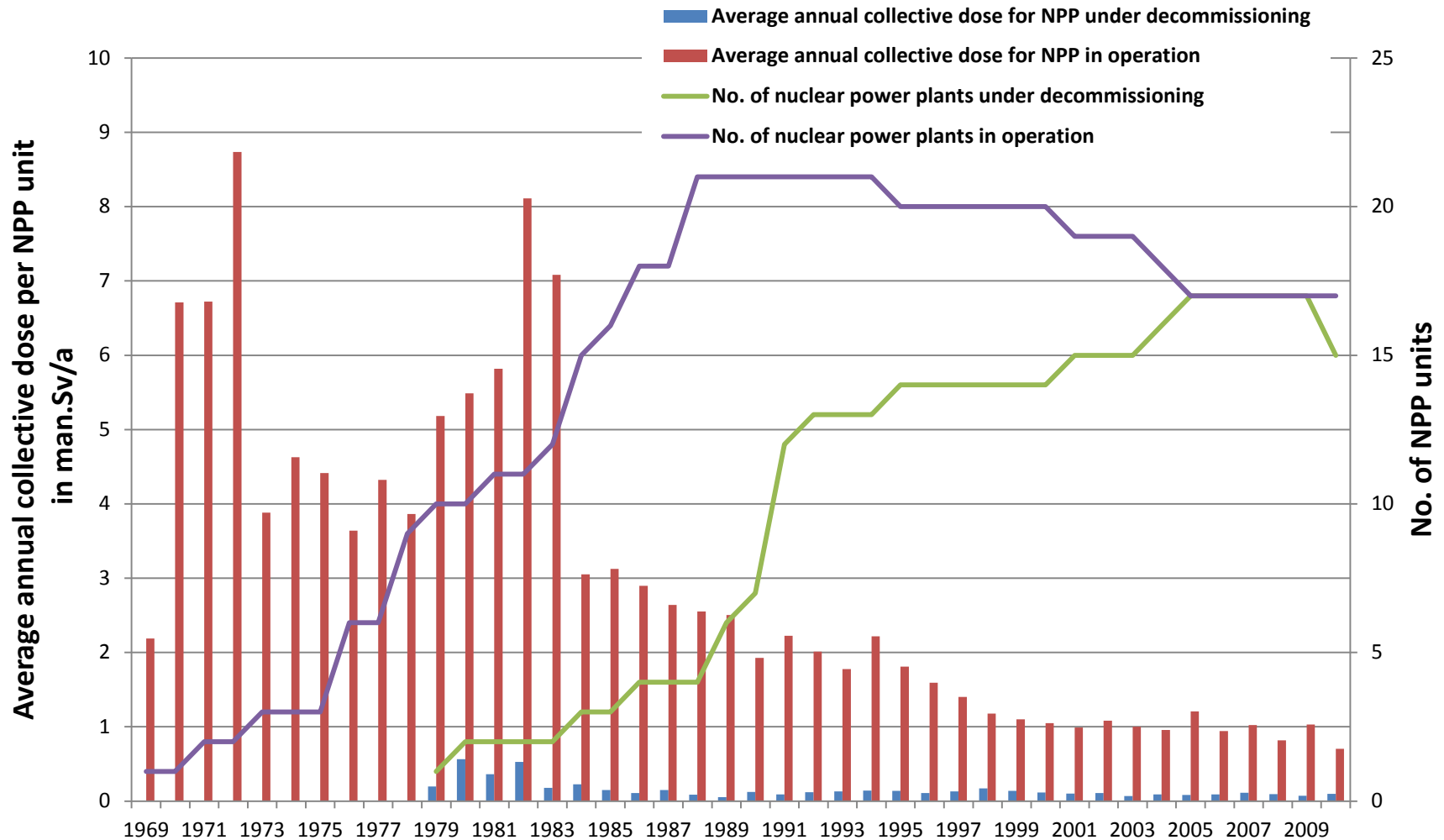
Overview on Occupational Exposure during Decommissioning of NPPs

- Evolution of average annual collective effective dose, based on data of a majority of worldwide NPPs – but note: influence of averaging!



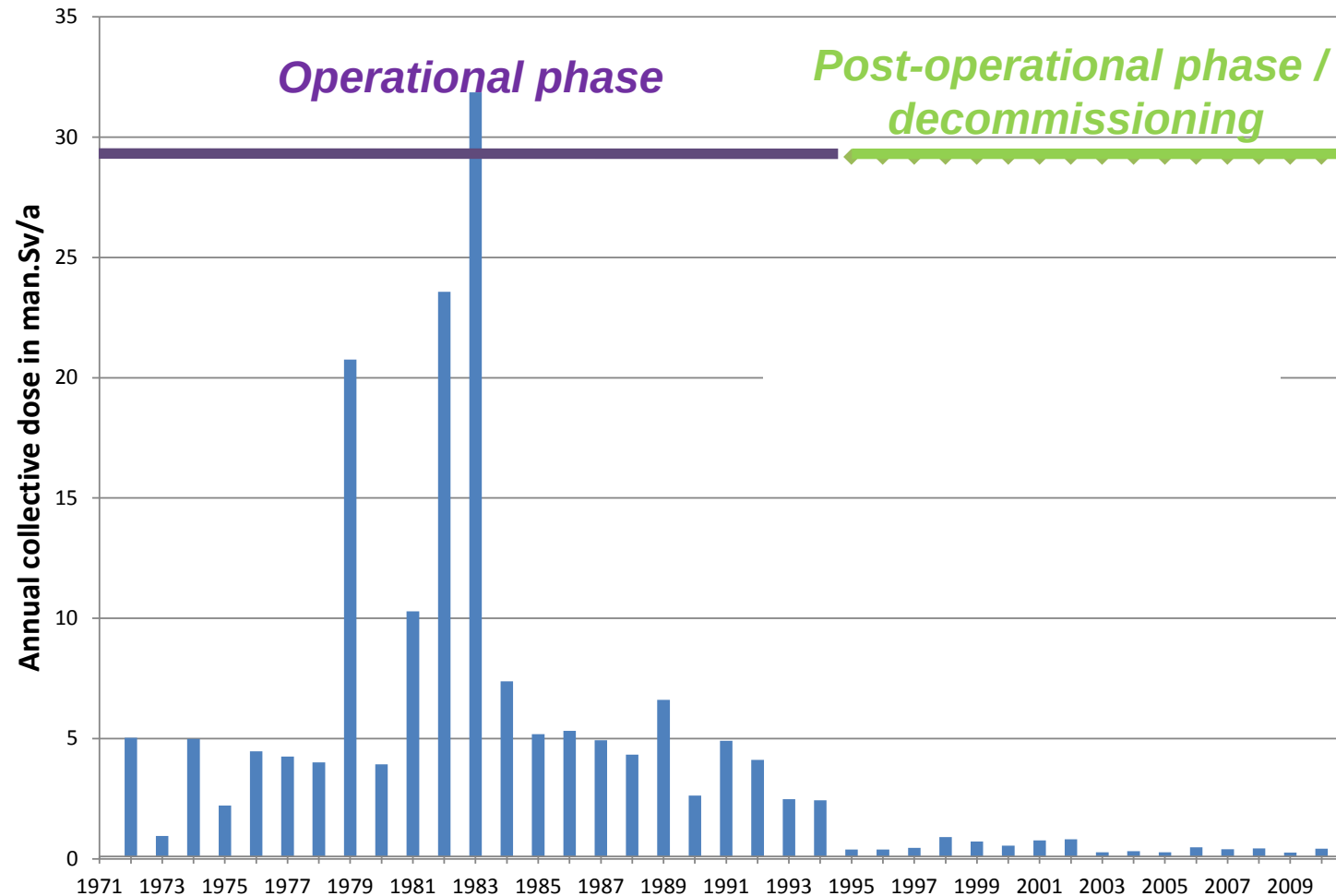
Overview on Occupational Exposure during Decommissioning of NPPs

- Evolution of average annual collective effective dose for German NPPs



Overview on Occupational Exposure during Decommissioning of NPPs

- Example on the evolution of the annual collective effective dose during life cycle of a NPP in operation and decommissioning



Overview on Occupational Exposure during Decommissioning of NPPs

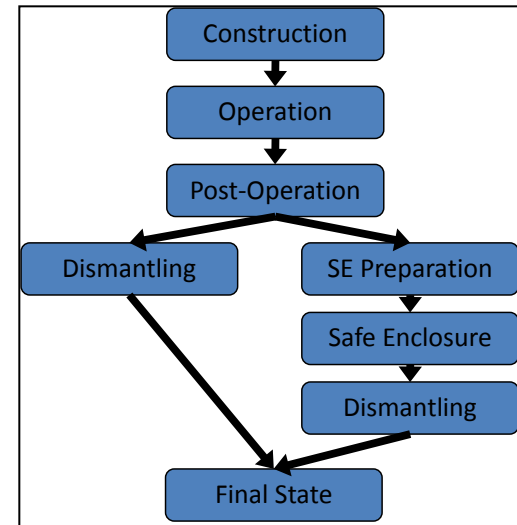
- Some key observations
 - (Average) Annual **collective effective dose** for NPPs in **operation higher than** for NPPs under **decommissioning**
 - depends inter alia on the reactor type and decommissioning concept / approach used
 - open question, whether this will change for modern reactor designs and for all current reactor designs (e.g. Candu)
 - Annual **collective effective dose** of a NPP under decommissioning **varies from year to year** and depends inter alia from
 - annual work load and project plan (structure & schedule) and progress of work
 - radiological conditions (e.g. contaminations, quality of system decontaminations)
 - Both, **utility and contracted personnel involved**
 - typically large number of contracted personnel active during whole year

“Daily” Radiation Protection Challenges during Decommissioning

- From a **far distance** – “**Decommissioning**” = “**extended Outage**”
 - ➔ no other “daily” challenges than during outage
- But from a **closer distance** – **aspects more relevant / new** now requiring
 - flexible planning, preparation & work control and establishment of oversight on all processes under conduct
 - early involvement of RP professionals
 - well RP trained personnel to appropriately respond
 - ➔ new “daily” challenges other than during outage, inter alia
 - continuous change of the facility status (technical, radiological relevant)
 - increased number of (long-lasting) work activities with interdependencies
 - access to workplaces, inaccessible during operation
 - new / improved techniques to conduct / speedup decommissioning activities
 - (need for) deviations from plans on the conduct of work
 - high volume of radioactive / non-radioactive material flow
 - replacement of technical barriers by administrative ones (incl. PPE)
 - ➔ but: **Decommissioning RP measures are mainly the same as for operation**

Selected Experiences from Past and Current Projects

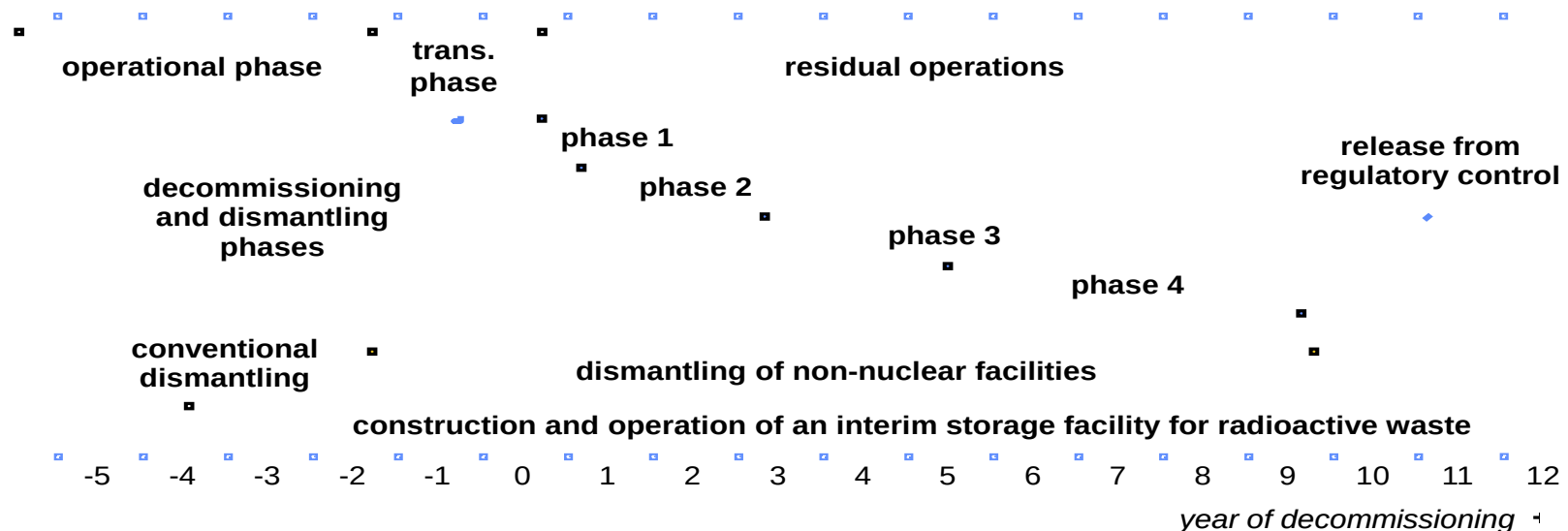
- Experience in general shows: radiation protection during decommissioning depends inter alia on
 - radiological situation of the nuclear facility
 - complexity of the nuclear facility
 - conceptual decisions as e.g.
 - decommissioning strategy
 - project structure / *multiple phase approach*
 - sequence of decommissioning activities
 - conduct of measures to reduce the radioactive inventory (e.g. full system decontamination)
 - *cutting of component in-situ or ex-situ, especially removal of large components*
 - *pre-selection of techniques*
 - waste management concept



Selected Experiences from Past and Current Projects

Multiple Phase Approach

■ Multiple phase approach

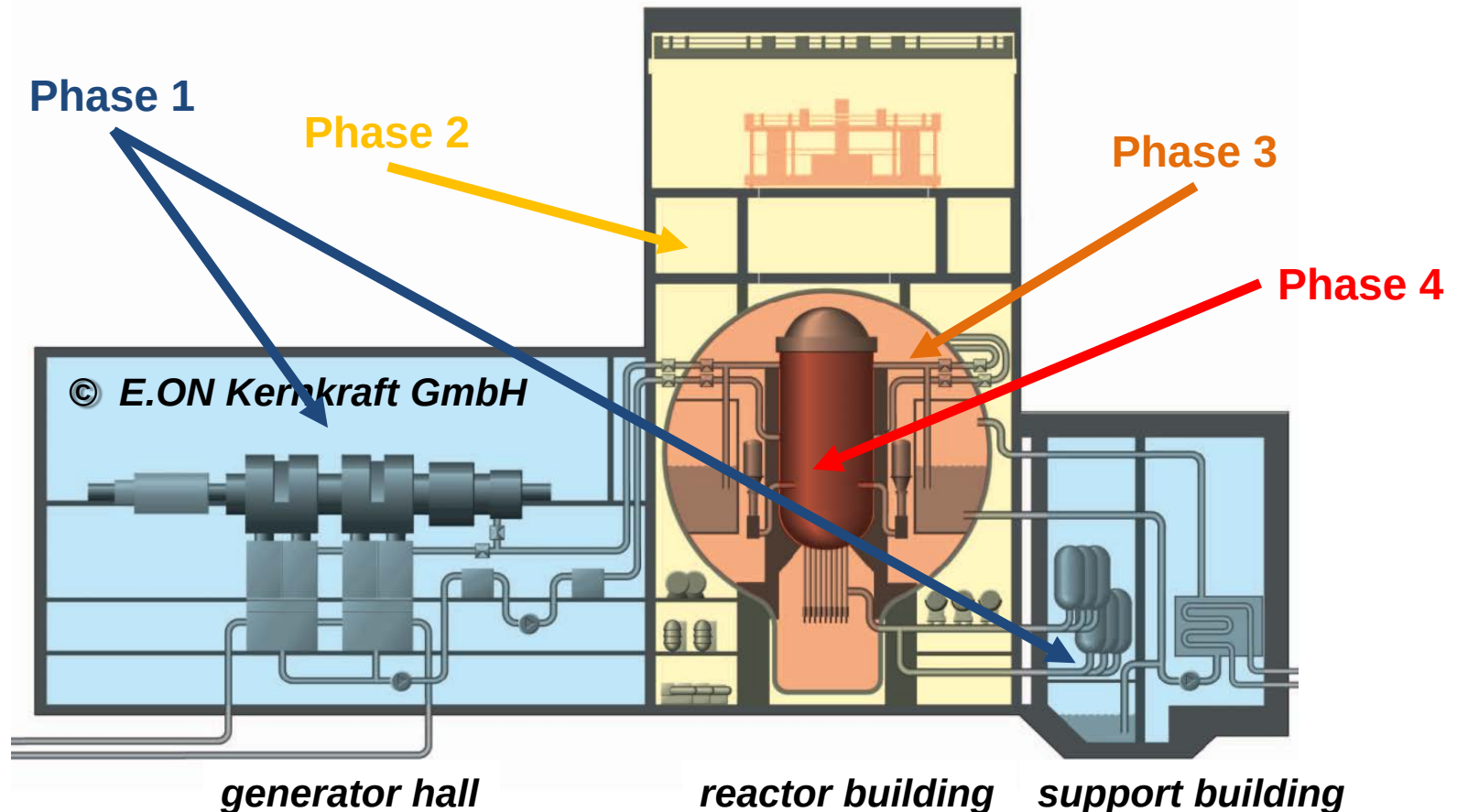


- serves to divide large projects into smaller parts and to reduce complexity
- allows stepwise planning of phases
 - first to be detailed
 - following less detailed until to commence (typically after approval by regulator)
- helps to stage the process of radiological characterization
 - information for later phases can be evaluated during current phases
- requires a clear adjustment of the individual phases

Selected Experiences from Past and Current Projects

Multiple Phase Approach

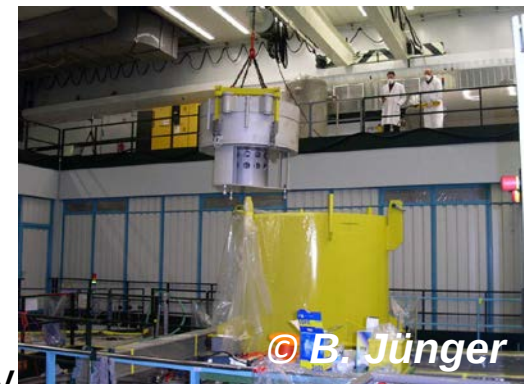
- Example for a multiple phase approach



Selected Experiences from Past and Current Projects

Removal of Large Components

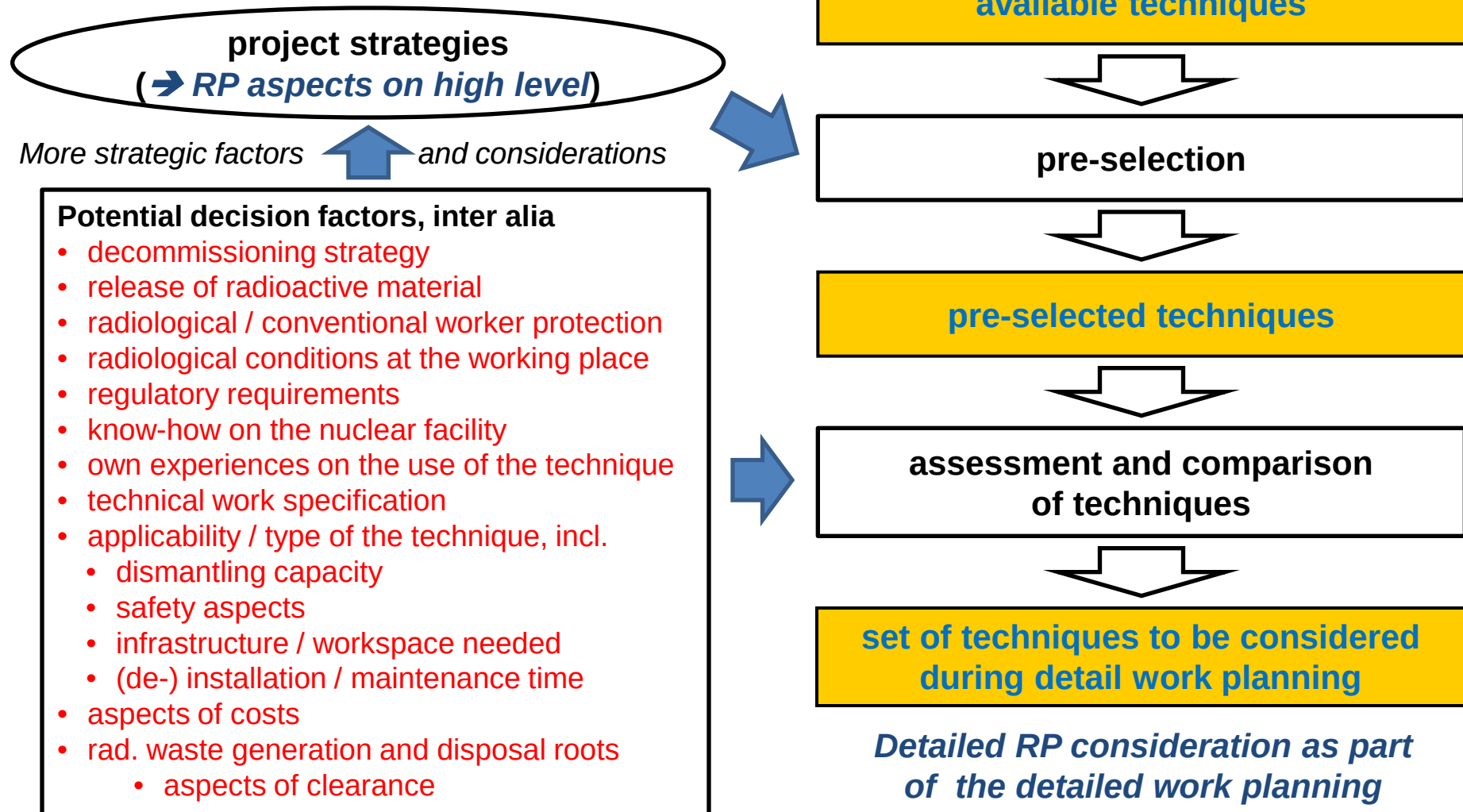
- As an alternative to in-situ dismantling and cutting of large components
 - removal of the whole component as one piece
 - dismantling at a different position than the build-in position (ex-situ)
 - within the nuclear facility
 - at the site in a specific facility
 - off-site, e.g. by a service provider
 - advantages
 - optimization of the schedule
 - improvement of radiological conditions (not necessarily resulting in lower doses!!)
 - closely related to waste management strategies
- Special form of removal of large component
 - removal and long term storage before dismantling
 - ➔ “decay storage” to take benefit from radioactive decay



Selected Experiences from Past and Current Projects

RP & Selection of Dismantling & Decontamination Techniques

- Generic selection process



Conclusions and ...

- In the past decommissioning of nuclear facilities was performed successfully (and safely) to reach defined end states
- “Daily” challenges require inter alia flexible planning & work control, management of many processes and an early involvement of RP professionals
- Recent experiences show inter alia
 - A multiple phase approach helps
 - to manage large and complex decommissioning projects and
 - to solve the problem of radiological characterizations during planning
 - Large component removal is a way to optimize project plans and to improve the radiological conditions for dismantling (but leads not necessarily to lower doses)
 - RP is considered on a high level in project strategies and in detail during work planning on base of selected techniques
 - worker protection will become ALARA during the detailed work planning
- Today, for (mostly) any technical question related to decommissioning
 - either standard solutions exist or can be adapted, or
 - can be individually developed for the specific situation

... and “Future Radiation Protection Challenges”

- In general terms, **RP challenges seem to be under control** for most situations, except for accident situations (➔ special challenge to remove spent fuel)
- “Future Radiation Protection Challenges” may relate to
 - the **radiological characterization** (before approval by regulatory bodies) which
 - sets the base for the preparation of decommissioning plans and
 - forms the basis the waste and material management strategies as
 - it's difficult **to decide on the appropriate level of detail**
 - to **gain the information** needed
 - the **final radiological survey**, which demonstrates that the final end state was reached as
 - especially in case of sites remaining contamination either of natural origin strongly vary or of artificial origin exist, both resulting in practical problems for a background identification and reduction
- ➔ further need on **experience feedback** among RP experts, e.g. by means of ISOE, IAEA / NEA

Thank You for Your Attention!