Experience in decommissioning of German NPPs

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NPPs in Germany – Status and Forecast

- Status of Nuclear Power Plants in Germany:
  - 8 units in operation (approx. 12.702 MWe)
  - 9 units in „continuous none power operation" after Fukushima event
  - 15 units in safe enclosure / decommissioning / decommissioned

⇨ By end of 2022, **ALL** German NPPs will be shut down!

- Worldwide many nuclear facilities have reached or are close to end of their design lifetime

⇨ Decommissioning will become a major task in the next decades

Experience in decommissioning in Germany

- Decommissioning activities in Germany have been started some decades ago
  - Research and Development has been performed
  - Many developments have been achieved, many lessons learned:
    - Technical: cutting/decontamination/treatment processes, handling, storage, etc.
    - Administrative: Legislation, Standards, Rules and Guidelines
  - First NPPs have been completely decommissioned
  - Future use concepts (e.g. industrial use of former NPP-site) have been implemented

⇨ Actually, a lot of knowledge and experience was gained

Decommissioning related challenges and experiences - Studies and preparatory works

Studies and preparatory works to start decommissioning:

- Concept development
  - Post operation (e.g. Downsizing)
  - Dismantling
  - Waste treatment
  - Storage
- Overall decommissioning strategy
- Radiological Plant characterization
- Decommissioning costs calculation

→ Many activities are needed until decommissioning can be started

Decommissioning related challenges and experiences - Studies and preparatory works

- Studies for decommissioning and waste deposition of single components and systems, as well as planing of the total decommissioning concept
- Dismantling of NPP systems: e.g. reactor pressure vessels and internals, steam generators, building structures, etc.
- Concept, qualification und procurement of monitoring systems for free release and waste characterisation
- Concept, design and building of storage facilities
- Engineering services

Decommissioning related challenges and experiences - Segmentation Technologies

- In former decommissioning projects a lot of different technologies have been developed and qualified for segmentation tasks

- No standardized concepts have been used, because of:
  - the wide variety of reactor designs and characteristics
  - the wide variety of segmentation tasks
  - different priorities of designers, customers and authorities

- No “allround” technology is available

⇨ A toolbox is needed to choose the “best” technical solutions

Decommissioning related challenges and experiences - Segmentation technologies

flame cutting

AWSJ

grinder

milling cutter

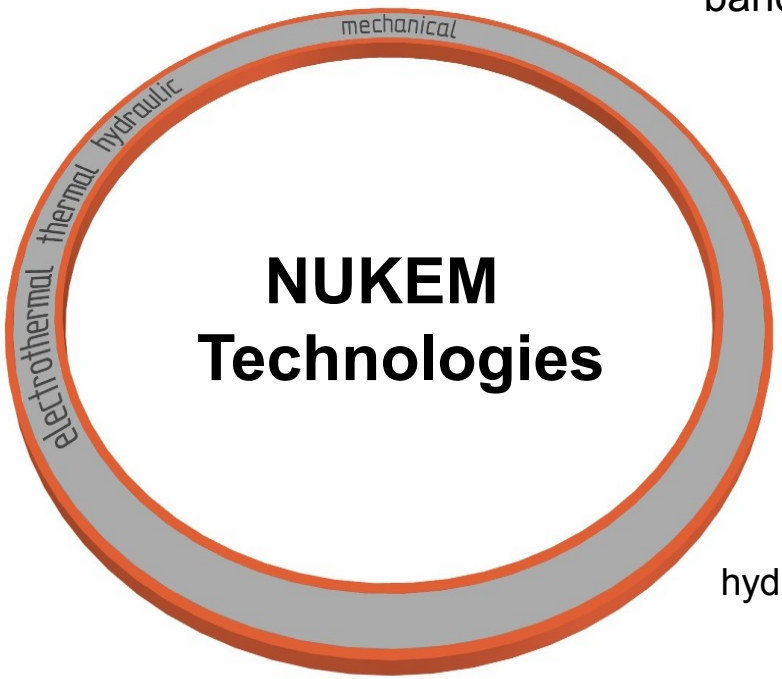
bandsaw

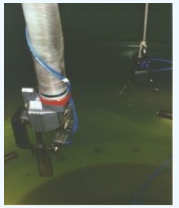
diamond wire cutting

plasma arc cutting

CAMC

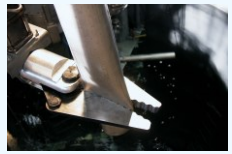
EDM





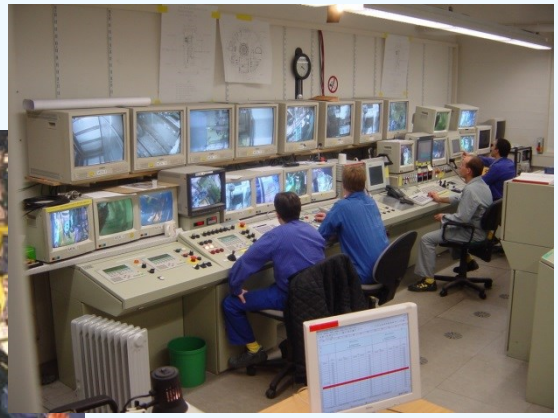
hacksaw

nibbler



hydraulic shear

Decommissioning related challenges and experiences - Segmentation Technologies



Central mast manipulator
in the reactor room used at MPRR
in Karlsruhe

Operation
by handling rods
used at VAK in Kahl

NUKEM´s strategy for present decommissioning project KKP Philippsburg: Decommissioning of reactor vessel

- Segmentation strategy:
  - In-situ pre segmentation
  - Final segmentation in separate confinement

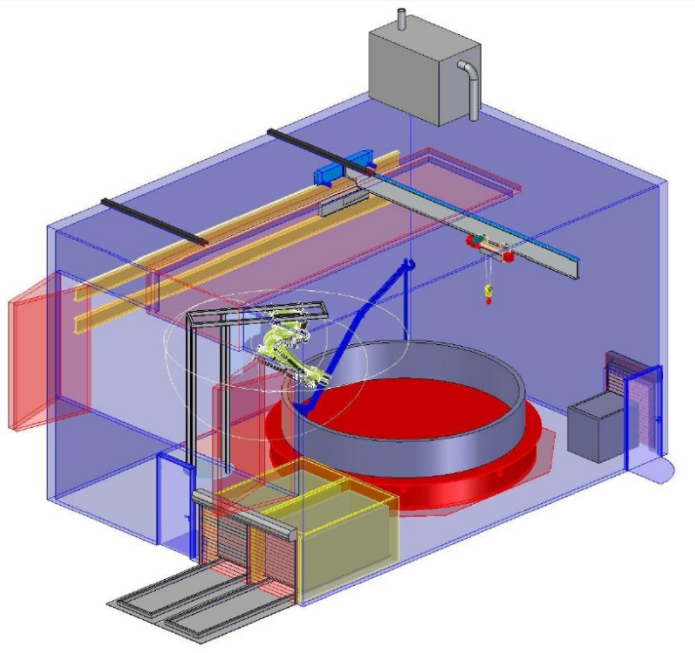
  ⇨ Low requirements to handling equipment
  Optimized segmentation time due to parallel

- Main segmentation process:
  - Autogenous flame cutting

  ⇨ High cutting speed
  Low maintenance and investment costs

- Secondary segmentation process
  - Diamond wire cutting

  ⇨ Very flexible considering part geometry



Confinement for final segmentation

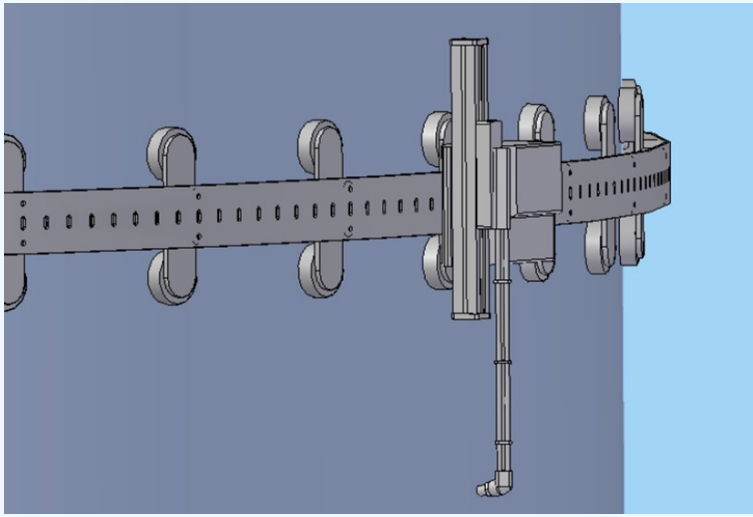
NUKEM´s strategy for present decommissioning project KKP Philippsburg: Decommissioning of reactor vessel

- Handling systems:
  - Industrial standard systems adapted to specific requirements
    - KUKA-robot with adapted software
    - Circular tractor system for pre-segmentation

⇒ High reliability
Minimum maintenance efforts

- General:
  - Flexible design of equipment

⇒ Potential re-use of equipment



Circular tractor system

Decommissioning related challenges and experiences - Decontamination Technologies

- Free release of materials is a major task in decommissioning projects
  - Reduce the amount of radioactive waste
  - Safe costs for storage and disposal

➡ Decontamination technologies are evident to achieve a free release

- Many different decontamination technologies are needed:
  - Concrete parts (Building structures, etc.)
  - Metal parts (Equipment, Steel constructions, etc.)
  - the wide variety of component´s geometry
  - Different types of contamination (surface contamination, activity, etc.)

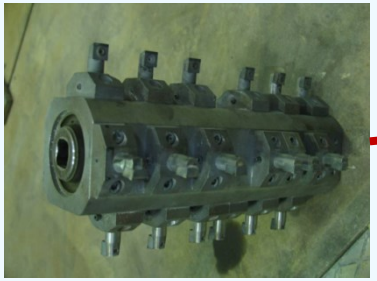
➡ Experience shows that a free release rate of more than 95% of the total NPP mass can be achieved

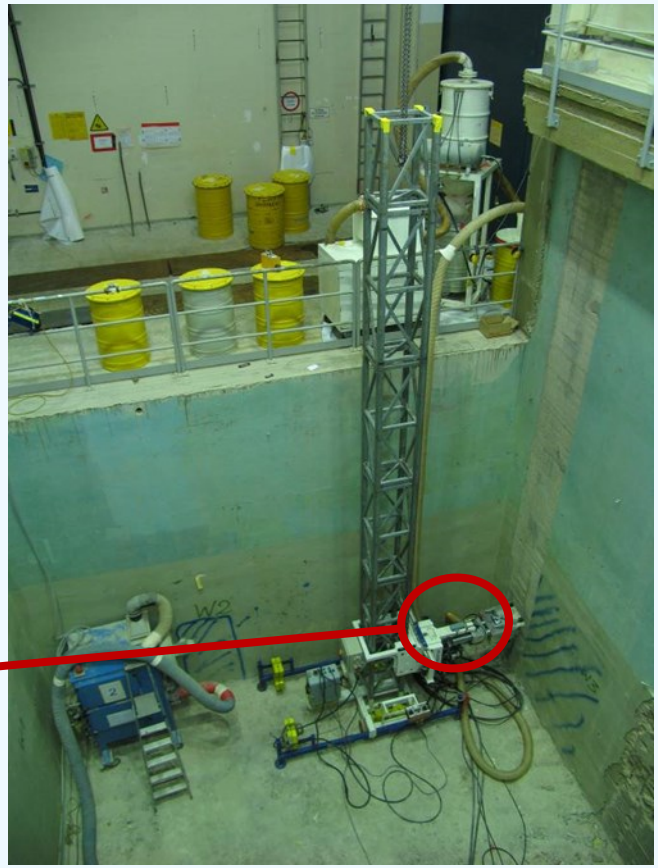
Decommissioning related challenges and experiences - Decontamination technologies

- Manual decontamination:

Decommissioning related challenges and experiences - Decontamination technologies

- Remote operated decontamination at VAK Kahl





Decommissioning related challenges and experiences - Monitoring systems

- Automatic monitoring systems to allow high throughput of materials:
  - Free release
  - Waste container characterisation

Decommissioning related challenges and experiences - Site remediation

- Free release of site area:
  - Removal of remaining materials (concrete structures, soil, pipes,…)
  - Measurement/ Sorting of materials
- Results from Fuel Fabrication Facility in Hanau:
  - Daily throughput: 200 bis 300 Mg/day
  - Total mass: 90,000 Mg (resulting in 400 Mg of radioactive waste)

NUKEM Technologies At A Glance

Core Competencies

- Waste Management
- Spent Fuel Management
- Decommissioning
- Engineering & Consulting
- HTR Fuel Technology

Key Markets

- Eastern Europe
- Western Europe
- South Africa
- Asia

Customers

- Nuclear power plants
- Nuclear research centers
- Nuclear fuel cycle industry
- Governments / Ministries / Organizations

Close to our Customers

- Headquarters in Alzenau, Germany
- Offices in
  - Russia / Ukraine
  - China
  - Lithuania / Bulgaria
  - France / Spain / Italy
  - Great Britain