



# Optimisation of RP during the Course of the Decommissioning of Spent Fuel Channels

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# Introduction

## **NPP Mühleberg, Switzerland**

- Latitude 46.969, Longitude 7.268
- BWR, Mark-I Containment
- Operating since 1972
- 373 MWe, 72.3 bar, 240 Fuel Elements
- Decommissioning commences in 2020

## **Segmentation and conditioning of spent fuel channels (FC)**

- Campaigns in  
1991, 1992, 1998, 2005, 2014, 2016
- Press-and-Cut-Method
- Conditioning of FC fragments in 200 lt drums

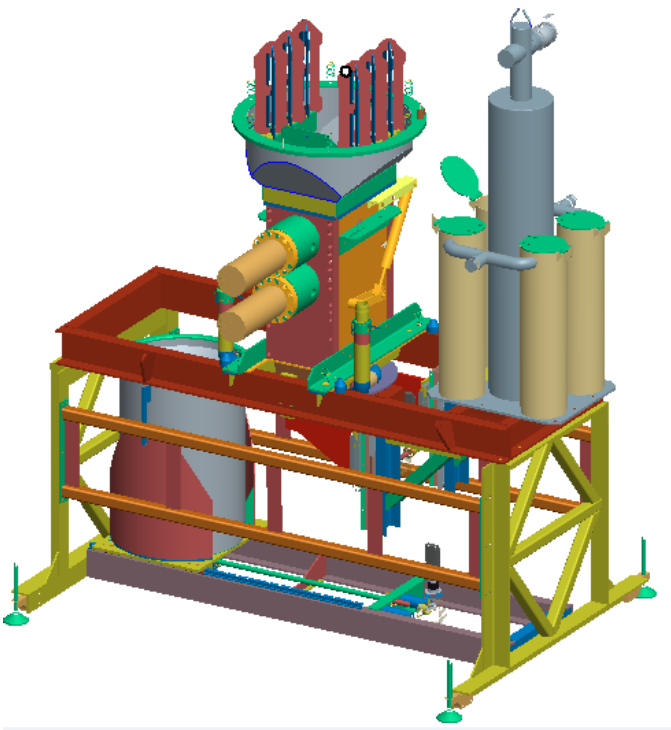


# Recent History of Spent Fuel Channel Decommissioning

- Campaign 2004/2005 was carried out by a different service provider with a different tool design. Technical difficulties and unplanned maintenance activities on the equipment resulted in high doses.
- Campaign 2014 was carried out by a new service provider with a new design of the underwater press.
- Although no unplanned maintenance became necessary, the campaign was stopped in the middle due to the low filling degree of the final storage units and the slow throughput of FC's in the process
- Clarifying discussions on management level as well as on project level (stakeholder involvement) were held between the service provider and KKM to clarify the expectations. Improvement plans were developed and agreed upon.
- A fundamental design overhaul was carried out by the service provider, reflecting and considering substantial input from the KKM project organisation (stakeholder involvement)

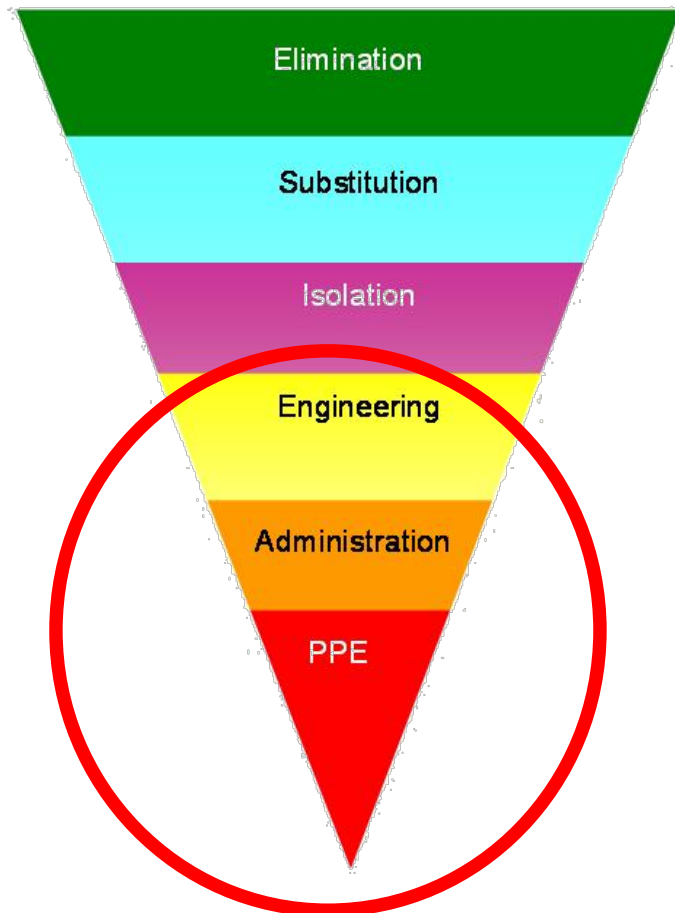


# Some impressions of the method and the process



# Aspects to consider in effective ALARA planning

## Hierarchy of controls



## PEMEM – Perspective

- **People:**  
competence, experience, organisation, interaction (teams)
- **Equipment:**  
suitability, simplicity, robustness, safety
- **Materials:**  
suitability, associated hazards
- **Environment:**  
present hazards, developing hazards
- **Methods:**  
suitability, simplicity, minimal collateral impacts, no additional risk induction

# Factors considered in the KKM Fuel channel compacting campaign

## People:

Experience &  
Knowledge Transfer

## Material:

Coating of  
equipment for easy  
decontamination



## Environment:

Water quality reduces  
ambient dose rate in  
the workplace

## Equipment:

- Simplicity in design & operation
- Simplicity in assembling & disassembling
- Strong water currents
  - Upfront testing

## Method:

- Press- cutting process
  - Post operation decontamination of FP makeup-system



# Fuel Channel conditioning – RP learnings

## ***Decontamination:***

- More collective dose was accumulated in the decontamination stage of the 2016 campaign.

## ***Causes & Contributors:***

- More equipment than foreseen was decontaminated
- Dismantling and decontamination of equipment not foreseen in the planning

## ***Learning:***

- Cut-off or intervention criteria's should be pre-defined not only for the task but also for supporting activities

| Step             | Dose planned [mSv] | Dose effective [mSv] |
|------------------|--------------------|----------------------|
| Assembling RB    | 0.65               | 0.60                 |
| Cutting RB       | 3.5                | 3.33                 |
| Disassembling RB | 2                  | 1.76                 |
| RP Services RB   | 3                  | 4.25                 |
| Conditioning     | 0.8                | 0.7                  |
| Decontamination  | 5                  | 9.45                 |
| RP Services TB   | 0.4                | 0.25                 |
| Others           | 0.5                | 0.25                 |
| Total            | 15.85              | 20.59                |

# Fuel Channel Conditioning

## Performance benchmark of last three campaigns

|  | Noell 2004/2005 | WSE 2014 | WSE 2016 |
|--|-----------------|----------|----------|
| No of shifts                           | 2               | 1        | 1        |
| Filling degree [FC / drum]             | 5-7             | 3-4      | 5-6      |
| Conditioned FC total                   | 345             | 151      | 149      |
| Conditioned FC / shift                 | ca. 9           | ca. 7    | ca. 11   |
| Drums per day                          | 3               | 2        | 2        |
| Collective dose total [mSv]            | 126             | 23.3     | 20.6     |
| Collective dose / drum [mSv]           | 2.1             | 0.46     | 0.66     |
| Collective dose / FC conditioned [mSv] | 0.036           | 0.015    | 0.014    |
| Repairs during the campaigns           | ja              | nein     | nein     |
| Summary: Filling Degree                | 😊😊😊             | 😞😞😞      | 😊😊       |
| Throughput                             | 😊               | 😞        | 😊😊       |
| Collective dose                        | 😞😞😞             | 😊😊       | 😊😊       |
| Maintenance / Repairs                  | 😞😞😞             | 😊        | 😊        |

# Fuel Channel Conditioning – lessons learned

## Confirmation of well known factors:

- Integration of all **stakeholders** in the planning process is crucial!
- **PEMEM & Hierarchie of controls** are important **optimisation principles**
- Economic solutions are ALARA – ALARA solutions are economic solutions

## Next Level – Substitution!

- Store spent fuel in storage casks within their spent fuel channels!  
No further channel conditioning necessary!

Questions?





# Many Thanks for Your Attention

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