Proven In-Situ Segmentation Combined with Off-Site Treatment for Volume Reduction and Recycling – RPV case study

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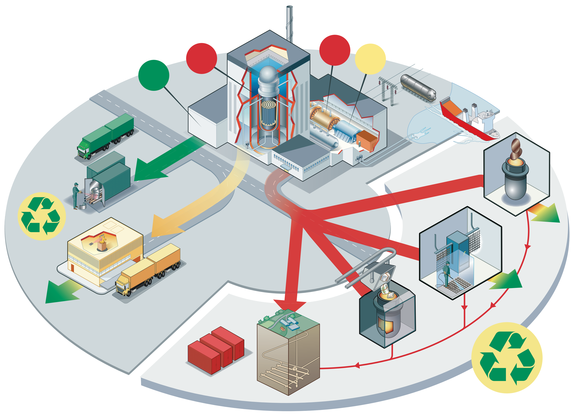
Abstract

- Decommissioning of NPPs generates large volumes of radioactive or potentially radioactive waste
- The proper management of the large components and the dismantling waste are key success factors in a decommissioning project
- BWR RPVs can be disposed of as is or be segmented, treated, partially free released for recycling and conditioned for disposal in licensed packages
- This case study uses proven technology and shows that
  - RPV in-situ segmentation combined with off-site treatment will open up for clearance and recycling
  - Disposal volume can be reduced with at least 90%
  - More than 70% of the metal can be subject for clearance and recycling
  - Benefits
    - Independent of repository extension
    - Repository concept do not require tunnel for RPVs and other large components

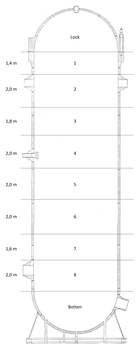


Introduction

There is need for development of the decommissioning process in order to minimize the economic consequences for facility owners and the community. A smooth and environmental friendly decommissioning process is also important to prove that nuclear energy is a sustainable energy source i.e. a platform for nuclear new build.

Discussions are on-going to find the optimal solution for handling of the BWR RPVs, four alternatives could be identified:

- Dismantling and disposal of whole RPV with or without interim storage waiting for disposal facility to be ready.
- Dismantling of whole RPV, transportation to Studsvik for treatment with the intension of free release of the majority of the material and volume reduction of the remains.
- **Segmentation of the RPV in-situ at the NPP. Packing in containers for transportation to Studsvik for treatment and free release of the majority of the material.**
  This alternative has been studied by ndcon.
- Segmentation of the RPV in-situ at the NPP. Packing in containers for transportation to the disposal facility without any further treatment or free release of the material.



Assumptions for handling of the BWR RPVs

The assumptions for the study are:

- Calculated inventory for the objects taking decay up to year 2017 into account
- Most of the surface contamination will be removed by decontamination (blasting)
- Melting, decay storage up to 25 years (as needed) and free release according to EC RP 89
- Segmentation is performed in large pieces (rings). The rings are further segmented to pieces of 10-20 tons.
- Loading in IP-2 containers. Transportation to Studsvik. Short turnaround time.
- Higher nuclide content in the RPV of Unit 2 compared with Unit 1
- The material for potential free release has been grouped as follows:
  - Direct free release after melting
  - Free release within ten years after melting
  - Free release within 10-25 years after melting
  - Material for disposal at SFR

Off-site treatment

- RPV in-situ segmentation needs to be combined with off-site treatment to optimize the result
- Treatment at Studsvik using proven methods and experience from similar RPV projects
- Based on the previous projects, it can be concluded that
  - The time for segmentation is short, and the Rip and Ship concept can be used
  - The transportation costs will be low (<1 SEK/kg)
  - No additional transportation cover or shell will be needed

Volume reduction and recycling

- Disposal volume per RPV can be reduced from 600 m^3 to <60 m^3
- Degree of free release of material >70%

	Unit 1 (tonnes)	Unit 2 (tonnes)
Direct free release	189	178
Free release after 10 years decay	168	146
Free release after 25 years decay	55	66
Disposal at SFR	121	143
Secondary waste incl isolation (4 %)	21	21
Degree of free release	74%	70%

Acknowledgement

Barsebäck Kraft AB is acknowledged for providing RPV data for this study and for the approval for its publication.

Calculation of RPV activation

Direct free release of ingots

-10 yr ingot decay storage

10-25 yr ingot decay storage

To be disposed as radioactive waste

Between cm		B1 Cladding	B1 Base material	B2 Cladding	B2 Base material
1150	top	0	0	0	0
1100	1150	0	0	0	0
1050	1100	0	0	0	0
1000	1050	0	0	0	0
950	1000	0	0	0	0
900	950	0	0	0	0
850	900	0	0	0	0
800	850	0	0	0	0
750	800	0	0	10	10
700	750	10	10	25	10
650	700	10	10	25	25
600	650	10	10	25	25
550	600	25	25	25	25
500	550	SFR	25	SFR	SFR
450	500	SFR	SFR	SFR	SFR
400	450	SFR	SFR	SFR	SFR
350	400	SFR	SFR	SFR	SFR
300	350	SFR	SFR	SFR	SFR
250	300	SFR	SFR	SFR	SFR
200	250	SFR	SFR	SFR	SFR
150	200	SFR	SFR	SFR	SFR
100	150	SFR	SFR	SFR	SFR
50	100	SFR	SFR	SFR	SFR
0	50	SFR	SFR	SFR	SFR
-50	0	SFR	SFR	SFR	SFR
-100	-50	SFR	25	SFR	SFR
-150	-100	25	25	SFR	25
-200	-150	25	25	25	25
-250	-200	10	10	25	25
-300	-250	10	10	25	10
-350	-300	10	10	25	10
bottom	-350	10	10	10	10
	RPV Head	0	0	0	0

Container/disposal route optimization

- Containers for reactor internals are very expensive and so far not approved for disposal
  - ⇨ should be used only when needed
- Activated material has a built in barrier
- Only a minority of the RPV waste requires advanced disposal packages
  - ⇨ conditioning in existing containers will meet WAC
  - ⇨ complementing variants may be required for a minority of the waste

Conclusions

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