Impact of metals recycling on a Swedish BWR decommissioning project

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Studsvik, Nyköping, Sweden

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Agenda

• Important aspects in decommissioning waste management
• Study on BWR decommissioning object
• References
• Conclusions
Important aspects in decommissioning waste management
D&D Waste Stream Overview

- Extremely low risk for contamination
- Low risk for contamination
- Risk for contamination
  - VLLW
- LLW
- ILW

Typical material for Off-Site Treatment
Environmentally Sound Decommissioning

Implement the Waste Hierarchy

- Prevent generation of waste and especially radioactive waste
- Minimize waste volumes for final disposal
- Focus on recycling of materials
- Traceability, efficient logistics, established waste routes and sustainable processes are key success factors
ndcon Waste Management Concept

Plant Status - Planning - Categorization - Risk Assessment - Action - Treatment - Final State

Radiological characterisation

Development of detailed work packages

Divide RW waste streams into risk/radioactivity based categories

Extremly Low Risk
Low Risk
Risk / VLLW
LLW
ILW

No Action
No need for formal Free release

Spot checks
Not clean

Waste to off-site waste treatment

Waste to disposal

Decontamination and Free release

Melting
Incineration
ILW Treatment of metals

Conditioning

Free release Free use
Conditional Free release material
Conditional Free release RP89

Disposal
D&D minimisation of disposal volumes

Reduction of disposal volumes reduces total D&D cost
Planning Phase

- Define waste management strategy
  - On site clearance activities
  - Off-site treatment and clearance
  - Waste for direct disposal
- Secure competence and understanding
- Secure waste routes – reserve capacity
- Define/refine dismantling sequence
- Consider recycling in licensing process
- Identify risks and bottle necks

The importance of the planning phase can not be overestimated!
Dismantling

- Keep categories apart
  - Non-radioactive (extremely low risk)
  - Low risk
  - Risk/VLLW/LLW

- Secure traceability and documentation

- Consider waste handling prior to and in all dismantling activities

Waste led dismantling reduces total decommissioning cost!
Waste Treatment

- Ship large contaminated components off-site early
- Focus on-site waste management on material categorized as
  - Extremely low risk
  - Low risk
- Minimise efforts for off-site treatment materials
- Traceability and documentation

Analyse and follow bottle necks closely – do not wait with actions
Study on BWR decommissioning object
Considered waste strategy for the study

- Use risk-based waste management
- Link characterisation - categorization - waste management = > cost-effective clearance/waste conditioning
- Seek harmony with the waste hierarchy (i.e. focus on reuse and recycling)
- Combine on-site and off-site treatment
- Advanced decontamination and clearance processes on site require substantial investment on the decommissioning site
- Focus on reaching an end-state for the material as early as possible – waiting is never cheaper
Exits for radioactive waste

• Clearance for free use

• Conditional clearance
  – Conditional use/recycling/conventional disposal based on 10 μSv principle (special license)
  – Ingots from melting (EC RP89, special license)

• Final disposal as radioactive waste
  – SFR (radioactive waste, mainly short lived nuclides)
  – SFL (radioactive waste, long lived nuclides)
  – Land fill (if necessary, if possible)
Transport Concepts

Transport types:
- Containerized
- Large components

Shipments of radioactive waste are routine operations performed daily
Waste streams

Total amount VLLW/LLW to disposal not considering recycling approx. 18 000 ton (TLG-study)

Assumptions:

• Decont (as necessary) and clearance 30% (5400 ton)
• Off site metal treatment 38% (6800 ton)
• Incineration 2 % (400 ton)
• Material for direct disposal 30% (5400 ton)
Impact by implementation of waste hierarchy

Waste for disposal (incl. estimated amounts of material sorted out):

- **Decont (as necessary)** and clearance: 5% of 5400 ton => 270 m$^3$ (4%)
- **Off site metal treatment**: 5% of 6800 ton => 340 m$^3$ (6%)
- **Incineration**: 5 % of 400 ton => 20 m$^3$ (<1%)
- **Direct disposal**: 100% of 5400 ton => 5400 m$^3$ (90%)

**TOTAL** = 6000 m$^3$

**Disposal volume VLLW/LLW** 18000 m$^3$ => 6000 m$^3$
Calculation of RPV activation

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Direct free release of ingots

-10 yr ingot decay storage

10-25 yr ingot decay storage

To be disposed as radioactive waste
Volume RPV reduction and recycling

• Disposal volume reduction from 600 m$^3$ to <60 m$^3$ per RPV

• Degree of free release of material >70%

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<th>Unit 1 (ton)</th>
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<td>Direct free release</td>
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<td>Free release after 10 years decay</td>
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<td>Free release after 25 years decay</td>
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<td>Disposal at SFR</td>
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<td>Secondary waste incl. isolation (4%)</td>
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<tr>
<td>Degree of free release</td>
<td>74%</td>
<td>70%</td>
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LLW waste disposal volume

![Bar chart showing LLW waste disposal volumes for Model A (SFR) and Model B (Studsvik)]
References
Example of waste streams

BWR upgrade project

Metals from BWR decommission project (example)

- Mainly scrap loaded in containers
- 5400 ton
- Percentage free release >95%

Low pressure turbines

- Clearance after treatment
- Waste for disposal

97%
Metal clearance through melting - Results

Generally a PWR D&D project generates less than 50% of waste than a BWR of similar size but with higher specific activity.

BWR reference
- More than 6000 tonnes has been treated
- Secondary waste in return: 3-4%(weight)

PWR reference
- More than 2000 tonnes has been treated
- Secondary waste in return 3-4%(weight) for containerized scrap
- Higher percentage secondary waste for steam generator
Conclusions

Recycling of metals from decommissioning of nuclear facilities is

• Well proven
• Cost efficient
• Sustainable

- Possible to adapt in different forms and combinations based on local conditions.
- Requires significant competence and a robust waste management structure.
Thank you for your attention