



# *Impact of metals recycling on a Swedish BWR decommissioning project*

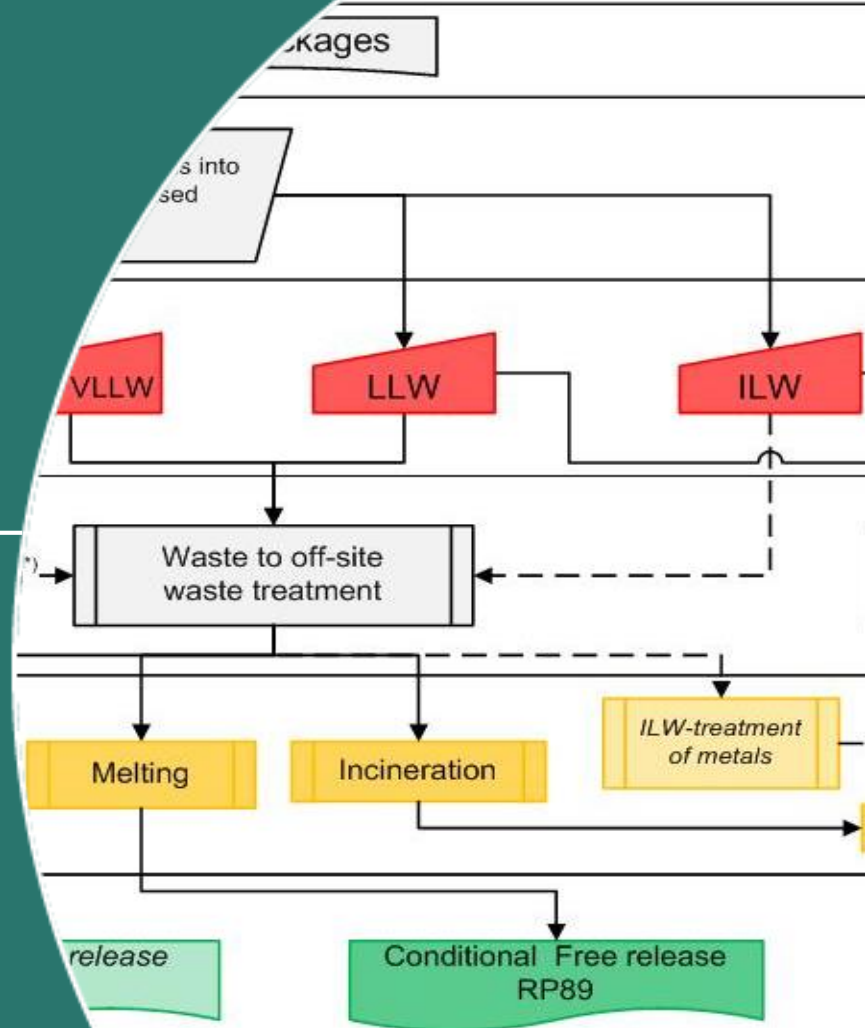
**Metals Recycling Symposium 2014  
Studsvik, Nyköping, Sweden**

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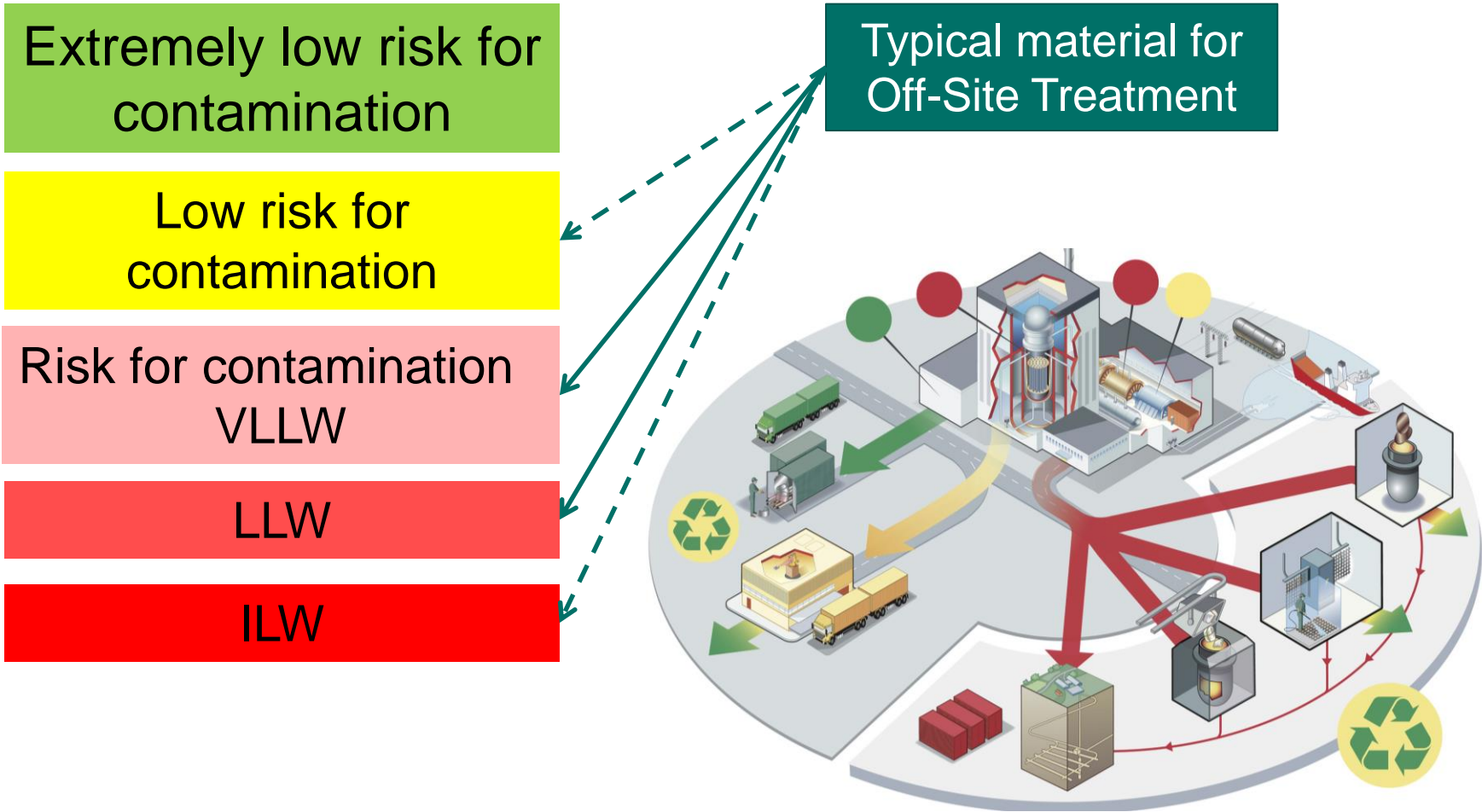
# Agenda

- Important aspects in decommissioning waste management
- Study on BWR decommissioning object
- References
- Conclusions

# Important aspects in decommissioning waste management



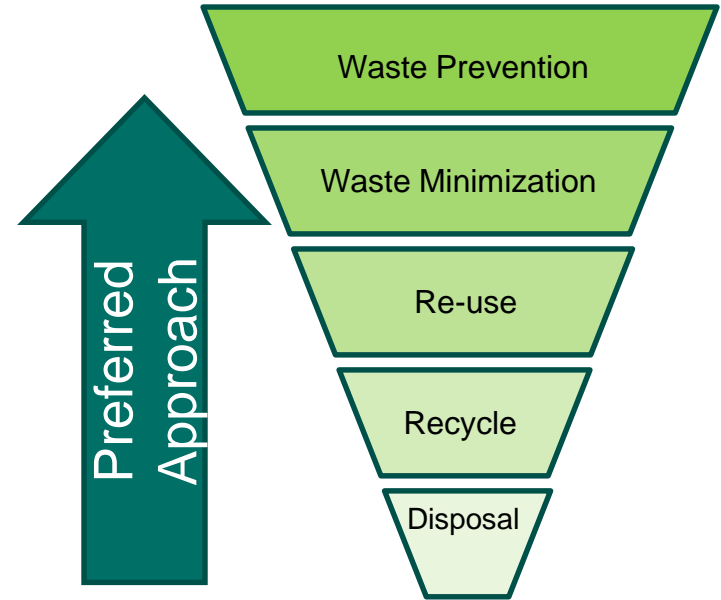
# D&D Waste Stream Overview



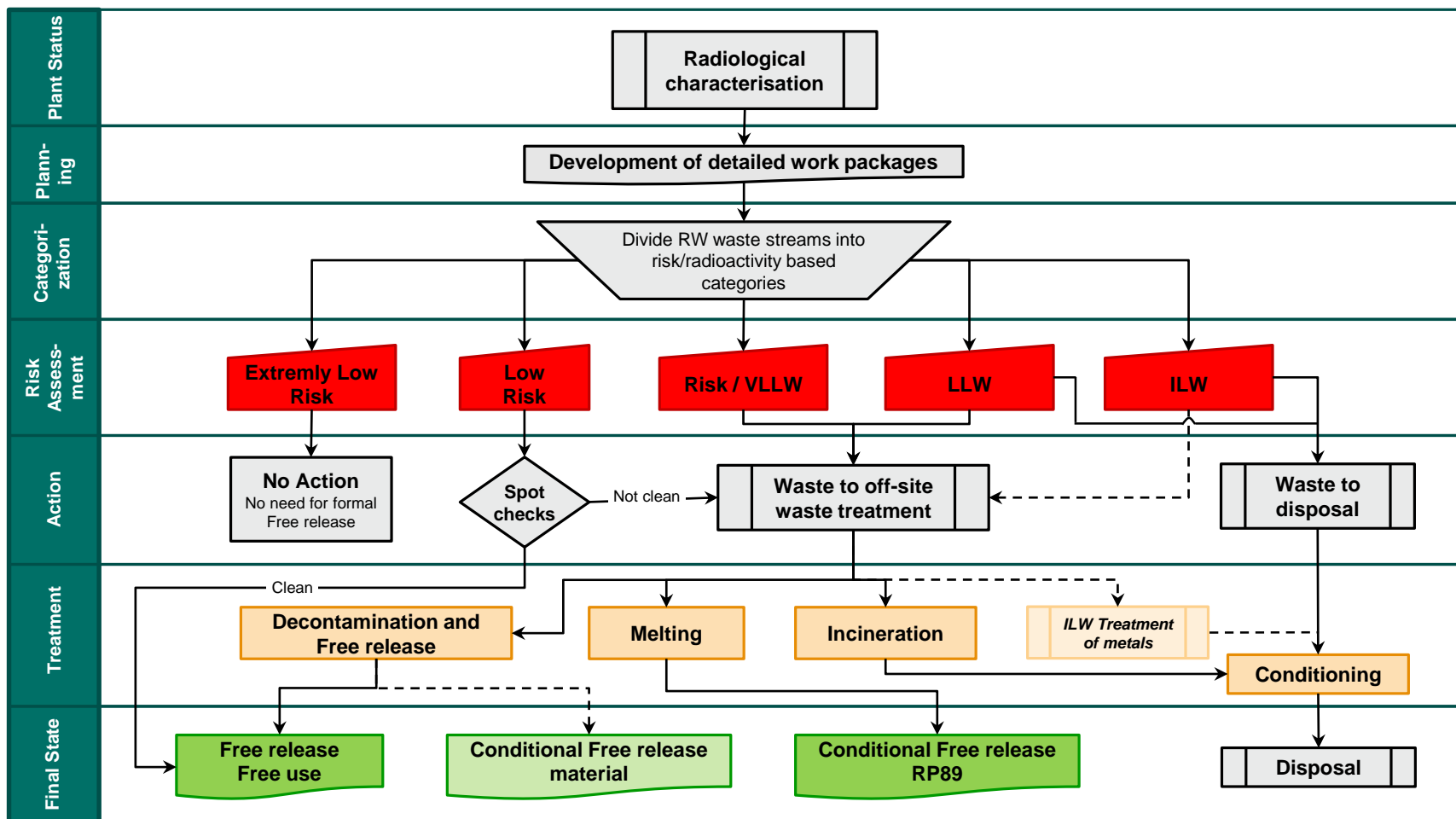
# Environmentally Sound Decommissioning

## Implement the Waste Hierarchy

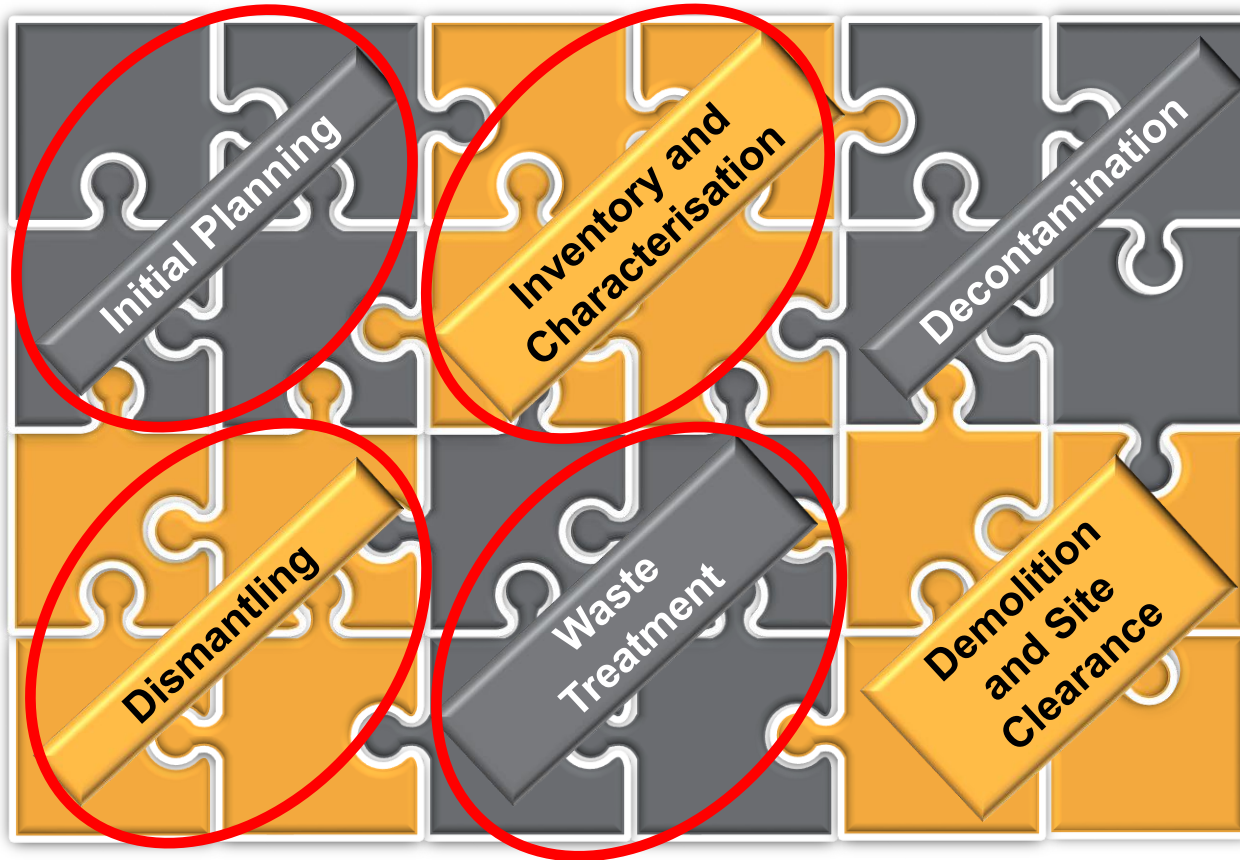
- Prevent generation of waste and especially radioactive waste
- Minimize waste volumes for final disposal
- Focus on recycling of materials
- Traceability, efficient logistics, established waste routes and sustainable processes are key success factors



# ndcon Waste Management Concept



# 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  $\mu$ Sv 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<sup>3</sup> (4%)
- Off site metal treatment      5% of 6800 ton => 340 m<sup>3</sup> (6%)
- Incineration      5 % of 400 ton => 20 m<sup>3</sup> (<1%)
- Direct disposal      100% of 5400 ton => 5400 m<sup>3</sup> (90%)

TOTAL      = 6000 m<sup>3</sup>

**Disposal volume VLLW/LLW      18000 m<sup>3</sup> => 6000 m<sup>3</sup>**



# 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

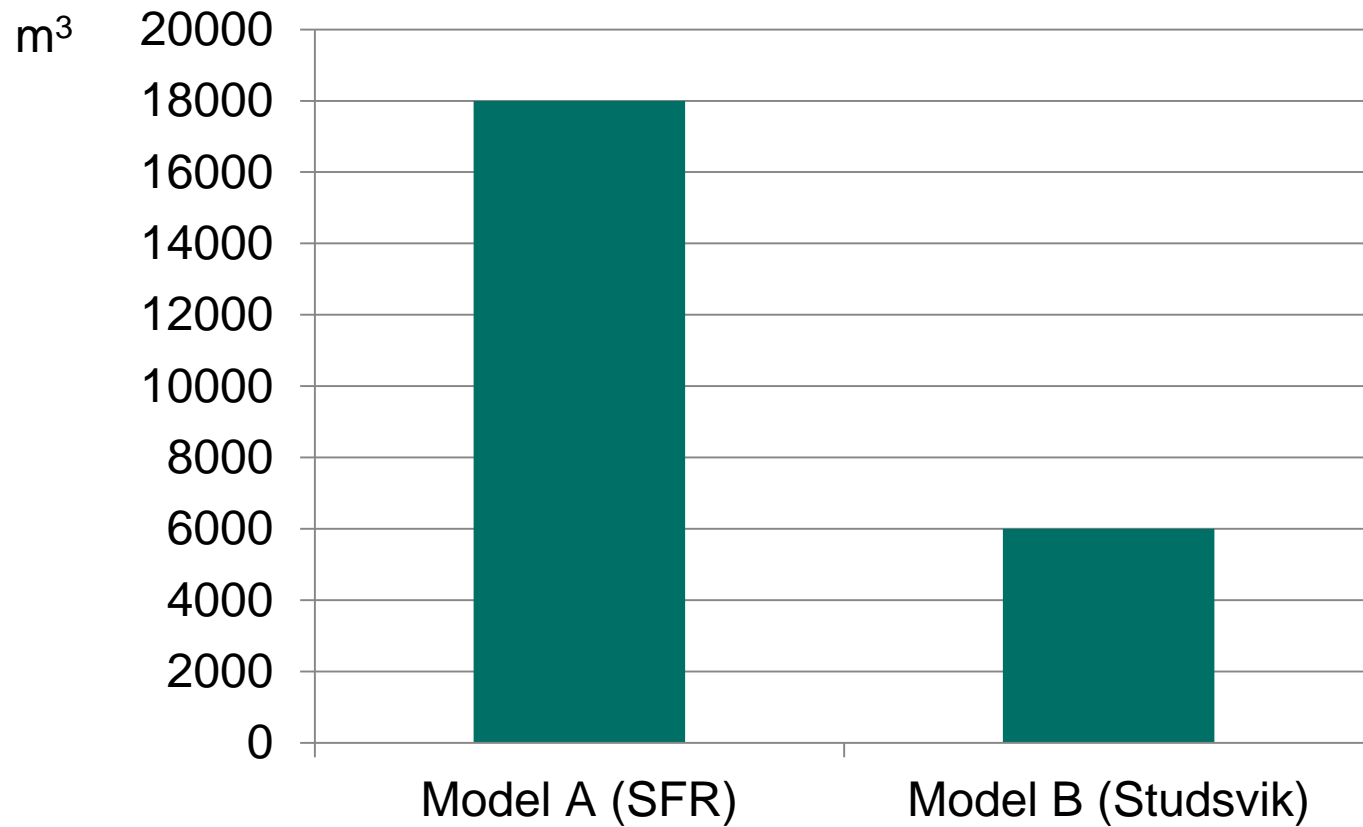
Between cm	Unit 1		Unit 2	
	Cladding	Base material	Cladding	Base material
1150 top	0	0	0	0
1100 1150	0	0	0	0
1050 1100	0	0	0	0
1000 1050	0	0	0	0
950 1000	0	0	0	0
900 950	0	0	0	0
850 900	0	0	0	0
800 850	0	0	0	0
750 800	0	0	10	10
700 750	10	10	25	10
650 700	10	10	25	25
600 650	10	10	25	25
550 600	25	25	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

# Volume RPV reduction and recycling

- Disposal volume reduction from 600 m<sup>3</sup> to <60 m<sup>3</sup> per RPV
- Degree of free release of material >70%

	Unit 1 (ton)	Unit 2 (ton)
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%

# LLW waste disposal volume



# References



# Example of waste streams

## BWR upgrade project

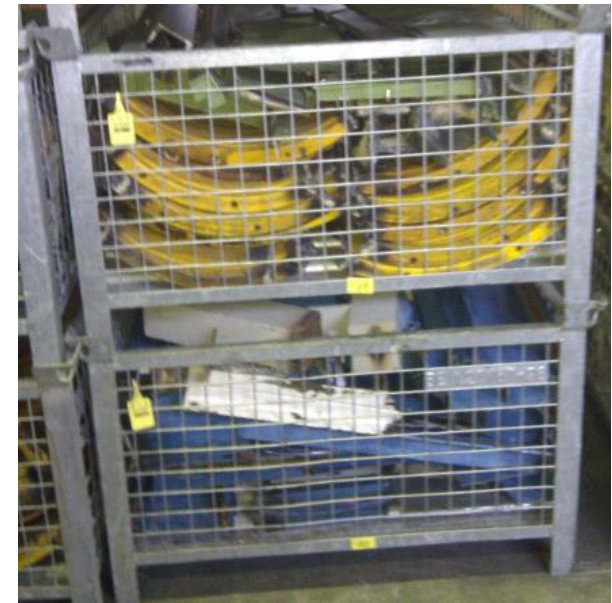


## Metals from BWR decomm project (example)

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

## Low pressure turbines

- Clearance after treatment
- Waste for disposal



# 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
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- 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

