Decommissioning Waste Management Planning for the Barsebäck Nuclear Power Plant

NKS-R Decommissioning Seminar 2013
6-7 November, Halden, Norway

Henrik Widestrand, Vattenfall Research & Development AB, presenter

Jennifer Möller, Vattenfall Research & Development AB
Leif Johansson, Barsebäck Kraft AB
Introduction

- Barsebäck Nuclear Power Plant in Sweden
- Barsebäck’s decommissioning strategy
- Waste management study
- Methodology
- Issues and challenges
Barsebäcks decommissioning strategy

- Safe
- Fast
- Cost-effective
Barsebäck is planned to be the first Swedish nuclear power plant to be dismantled.

Barsebäck 1 and 2 are located on the west coast of southern Sweden. Twin BWRs, 1800 MWth, 620 MWₑ.


Dismantling schedule tied to the opening of the final repository for decommissioning waste, planned for the 2020s.
Waste management study

- BKAB commissioned the study in 2011 and it was completed in 2012.

- The study is part of the pre-planning for dismantling.

- The study develops a general waste plan for dismantling by identifying, evaluating and recommending logistics and methods for dealing with different generated waste categories.

- Consideration of both onsite and offsite treatment of waste, “rip’n’ship”.

- Evaluate whether the two reactors should be dismantled in parallel.

- Studsvik Nuclear AB was a subcontractor in the study. They provided data on their capabilities for handling decommissioning waste from Barsebäck.
In order to facilitate the work, the project was divided into a number of different areas, including:

- waste inventories and descriptions,
- waste acceptance criteria,
- measurement and evaluation,
- treatment and packaging,
- buffer storage,
- plant adaptations,
- dismantling sequence and logistics,
- cost and resource estimates.
Previous studies and reports were available
- Decommissioning cost analysis
- Decommissioning plan
- Waste quantity estimates
- Activity inventory
- Study on removal of large components
- Dismantling study for concrete structures
- Barsebäck’s plant register
Methodology (cont.)

• Collection and compilation of data and information
• Onsite observations, walkdowns
• Benchmarking with other major waste management projects, including decommissioning
• Calculations
  - Waste quantities
  - Number and types of containers
  - Transport
  - Space for operation and staging
Waste inventory

- Quantities and types of waste generated are crucial to planning
  - Number of waste containers needed
  - Storage
  - Transport

- 4,000 to 12,000 tons of radioactive LLW and ILW waste to be sent to SFR

- Necessary to estimate the **volumes**, not only the weights
Waste inventory (cont.)

• How did we resolve this problem in the study?
  - Decommissioning cost analysis Inventory + Barsebäck plant register
  - Detailed inventory as part of planning

• How does it affect the results?
  - Waste quantities are key to planning capacity
  - The handling steps are the same
Logistics of handling waste

- Most active waste generated deep inside the plant
- Major operation to remove this waste from the building.
  - Heavy shielded packages must be handled with cranes
  - Risks of spreading contamination must be minimized
  - Personnel safety must be ensured
- Large quantities of different types of waste moved throughout the plant during dismantling
  - Important not to mix the various waste streams
  - Mixing waste streams leads to unnecessary handling
Logistics – recommended actions

• Physically separate the various waste streams as much as possible
  - This will optimize the logistics as well as protecting personnel from unnecessary radiation exposure

• Plant modifications will facilitate handling
  - Make the path to the packaging and then outside the facility as short as possible
  - New doors
  - Additional cranes
Logistics – recommended waste handling routes

- **LLW**
- **ILW**
- **Exempt Material**

Waste packaging

- Most of the waste is low-level and will be packaged and transported in 20-foot containers.
During the study several potential **bottlenecks** in waste handling were identified:

- Insufficient temporary storage for waste during peak production periods
- Time to fill containers as waste is produced
- Many simultaneous activities in the **transport corridors** inside buildings
- Many crane lifts necessary with limited equipment
- Time-consuming **measurements for clearance** required
- SKB’s **ship** Sigrid is available for the transport of decommissioning waste only during the summer
- Receiving facilities’ capacity to receive waste can be limiting
Solutions to minimise bottlenecks

- Plan sufficient capacity in free release measurement facility to deal with peak demand. Capability to operate three shifts when required.

- Utilize all building cranes to avoid excessive reliance on main reactor building crane.

- Plan for temporary container storage to cope with insufficient receiving capacity.

- Transport waste streams separately and in campaigns to avoid congestion in the main corridors.
Solutions to minimise bottlenecks (cont)

• Rooms and areas that are no longer in use can be converted for temporary storage of waste
  - Empty reactor pools, along walls of main transport corridor

• Packing of containers conducted in parallel with at least three separate container docking stations

• Supplement sea transports with road transports and hire in additional sea transport during the winter months
The dismantling sequence as originally proposed for Barsebäck was:

1. **Preparation** for decommissioning
2. Removal of the **reactor pressure vessel**
3. Removal of the most **active systems**
4. Removal of the **reheater, turbine and condenser**
5. System dismantling in the **reactor building**
6. System dismantling in the **turbine building**
7. System dismantling in the **waste building**
8. System dismantling in the **staff building**
9. System dismantling in the **service building**
10. System dismantling in the **AB-C storage**
11. **Conventional demolition** of the plant
Problems with the original dismantling sequence

• Did not fully consider the need to select suitable locations for carrying out activity measurements, loading of containers, temporary storage and waste routes

• Did not take into account of removing the reactor pressure vessels intact and demolition of the biological shields in large blocks.
Taking the deficiencies with the originally proposed sequence into account, the following modified sequence is proposed:

1. Demolition of buildings to make space in the Barseböck plant area
2. Preparations for dismantling inside the buildings
3. Removal of the most active systems in the reactor building
4. Preparations for dismantling for removal of the reactor pressure vessel
5. Removal of the reactor pressure vessel
6. Removal of the reheater, turbine and condenser
7. System dismantling in the reactor building
8. System dismantling in the turbine building
9. Removal of sand tanks
10. System dismantling in the waste treatment building
11. Removal of biological shield
12. System dismantling in the staff building
13. System dismantling in the service building
14. System dismantling in the AB-C storage building
15. Conventional demolition of the plant
The modified sequence takes into account the decommissioning and waste management logistics specific to the Barsebäck site.

- Takes into account the quantities of waste generated and from which location in the plant
  - The majority of the waste is produced in the reactor, turbine and waste treatment buildings

- Most active waste is removed prior to reactor pressure vessel removal (one piece vs segmentation)

- Option to start decommissioning of waste treatment building earlier in the sequence
Dismantling sequence optimisation (cont.)

1. Demolition of non-active buildings to make space within the Barsebäck plant area

1) Disused purified water tank,
2) Hydrogen gas building,
3) FILTRA system building,
4) FILTRA (Multi Venture Scrubber System)
Dismantling sequence optimisation (cont.)

4.5 Removal of reactor pressure vessel – new lift shaft required
Conclusion

- Waste management is the key to a successful decommissioning project
- Optimization of waste management needs to be integrated into the dismantling sequence
We wish to thank our sponsors at Barsebäck Kraft AB as well as our other colleagues at Vattenfall who contributed to the study: Veronica Wejander, Karin Snis, Johan Langham, Emil Boström and Magnus Oskarsson.
Thank you.
Henrik Widestrand
Vattenfall Research & Development
henrik.widestrand@vattenfall.com
Tel: +46 722 301718