

Planning for the Dismantling of the Barsebäck NPP - 14558

Håkan Lorentz

Barsebäck Kraft AB

Box 524, SE-246 25 Löddeköpinge, Sweden

ABSTRACT

E.ON is the owner to Barsebäck and Barsebäck Ltd is the holder of the nuclear license.

The status of Barsebäck is that all of the fuel and control rods are removed to a external interim storage. A full system decontamination is completed. Management of operational waste is ongoing. According Barsebäck's current planning, the final repository for short-lived low and intermediate level decommissioning waste will be ready to accept the waste, demolition preparations be completed and all permits have been obtained prior to the dismantling and demolition begins. It is also envisaged that the dismantling and demolition of Barsebäck 1 and Barsebäck 2 is implemented as a joint project, and that the requirements is completed before the project started. The end goal of this process is a site released for unrestricted use.

Barsebäck's focus of the decommissioning is that it must be safe, quick and cost effective. This means that potential risks are eliminated or reduced by reducing radiation exposure, which mainly takes place by performing system decontamination, and by the dismantling of large units. They also create the conditions for a smooth logistics primarily through detailed characterization, clear set of requirements, proper planning, approved type descriptions for each waste type and that the repository is ready to receive the low and intermediate level decommissioning waste. A cost-effective schedule is achieved by having a clear project management and planning for the five-year dismantling and demolition until radiologically cleared facility.

The timeframe to complete repository means that Barsebäck can conduct extensive qualitative studies, and analyze and benefit from international experience feedback with a focus on a safer, faster and more cost-effective demolition.

Barsebäck intend not to treat the radioactive waste arising in any significant degree on the site. This is to optimize the management and thus dose load. However, it may be necessary to send the very low-level demolition waste to melting and burning. All other short-lived low and intermediate level waste will be packed and sent directly to the repository. Core components are managed through interim storage until the repository is established and put into operation.

The total amount of waste, radioactive and non radioactive waste was estimated through a survey with a view to quantifying volumes and loads. The dismantling, demolition, waste management and transport will be implemented as an industrial process, with clear production approach. Low doses of radiation given priority, which means that radioactive waste is dismantled and transported in larger units and for free release treatment such as decontamination is carried out only when a reasonable value for recycling can be identified. This may lead to slightly higher volumes of radioactive waste but is offset by smaller doses to personnel, shorter schedule and overall lower utilization of resources. The plan is to dismantle the RPVs in one piece with no internal parts since the vessels will be disposed

throughout. A landfill for low-level waste will not be established at Barseback with regard to the facility shall be free released in their entirety. The radioactive waste to be deposited at an estimated 18 000 tonnes. The total demand for transport to the repository of waste packages deemed to two RPVs, approximately 800 pieces of ISO containers, about 300 pieces steel casks and about 80 pieces of steel tanks. Transport to the repository is expected to distribute itself evenly over the five years of the dismantling and demolition occurs. Radioactive waste that can be released is estimated at around 2 500 tonnes and is mainly items from the turbine plant that can be sent for smelting.

Segmentation of internal parts is one of the most time consuming tasks in connection with a demolition project execution. Barsebäck has established a project which includes segmentation and packaging of internal parts of the reactor tanks. The storage will be in a local newly built house for internal parts.

The construction of this storage is planned to start in 2014. Segmentation and transport of waste to the local storage is planned to start in 2015 and end in 2017. Transportation of steel tanks to repository is implemented when the transport cask and the facility is operational.

Barsebäck has conducted a series of studies prior to decommissioning where the most important include:

Dismantling and removal of one piece RPV, Segmentation of the RPV and internals, Radiological inventory, Identification and categorization of radioactive contamination in buildings and on land, Treatment of large components such as turbine, condenser, reheater and economizer, Demolition of the reactor building, Disposing of internal parts, 3D model has been created over the facility of land and buildings, Analyzes of requirements for decommissioning, Dismantling and waste logistics, Demolition of the turbine building and other buildings, Decontamination of building structures.

Barsebäck's ongoing and planned studies are a model for a site release, Preparation for service system during demolition, Organization of dismantling and demolition, Decontamination of pipes and tanks in the waste facility and a Communication Plan for stakeholders. Work on the development of regulatory approvals for dismantling and demolition will start up.

The overall planning is characterized at present by a number of pilot studies which will be compiled into the development of a project.

The schedule is to start the project in 2018 and to start the dismantling work in 2023 when the repository is planned to be in operation. Site released for unrestricted use is in 2029.

INTRODUCTION

Barsebäck NPP is owned by EON Kärnkraft Sverige AB (EKS), a subsidiary of EON Sverige AB. The nuclear power plant is located in southern Sweden on the west coast of Skåne.

Barsebäck 1 and 2

Type	BWR (boiling water reactor)
Capacity	1800 MWt, 615 MWe
Start of operation	1975 and 1977
Supplier	ASEA Atom
Owner	EKS
Operator	BKAB
Production	Total 93,4 TWh net(1999)/ 108 TWh net (2005)
Status	Permanently shut down since 30 November 1999/

Operating status 31 May 2005
Service operation (Care and maintenance) since 1 December 2006

Barsebäck 1 and 2 are two adjacent installations structurally linked via electrical buildings, control rooms and personnel buildings. A number of process systems are also integrated between the units. (*Picture 1*)



Picture 1 Barsebäck NPP in Sweden

HISTORY

In 1997 the Swedish Parliament passed the law on the phasing-out of nuclear power. The law entitles the government to decide whether the right to operate a nuclear power plant should cease.

On 5 February 1998, the government decided that Barsebäck 1 should cease operation in June 1998. An appeal to the Supreme Administrative Court meant that the closure was temporarily postponed. After the Supreme Administrative Court declared that the government's decision should stand, Barsebäck 1 was closed permanently on 30 November 1999.

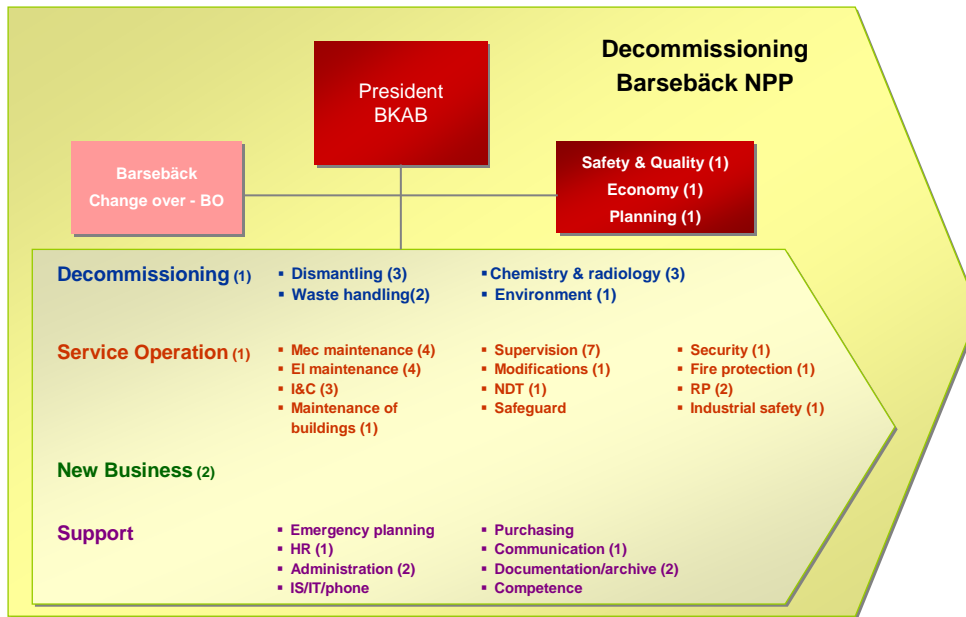
When the final political decision was taken that Barsebäck 1 would close down, the management of the company, together with the trade unions, set up projects called The Future Factory/The New Factory with the aim of carrying out a broad preliminary study of possible future scenarios and of describing these from the corporate and individual point of view. The employees of Barsebäck Kraft AB did the work with a high degree of participation.

On 16 December 2004, the government decided, on the basis of the law on the phasing-out of nuclear power that Barsebäck 2 should close on 31 May 2005.

Barsebäck 1 and 2 have been in Service operation (Care and maintenance) since 1 December 2006, when all fuel has been transported away to interim storage to CLAB in Oskarshamn.

ORGANIZATION DURING SERVICE OPERATION

There was a re-organization at BKAB in 1 January 2007 and the company is organized in the following area of functions (*Picture 2*)



Picture 2 – BKAB organization during Service operation

- **Site Service operation** – the mission is to secure that plant has the right status during service operation and to support the future dismantling. The Area includes supervision, maintenance, modifications, inspection, security, fire safety, waste management, occupational health, radiation protection and environmental issues.
- **Decommissioning planning** – the mission is to develop conditions for a safe and cost-effective dismantling.
- **New business** – on businesslike conditions use the site for other activities. We can offer buildings and systems (as an example Barsebäck Test & Maintenance Centre), offices, sell components and equipment.
- **BO – Barsebäck replacement department** – This department gave support to staff during the 3 years of employment guarantee to turn over new employment/occupations. This Department was closed down at 31 December 2013.

The Organisation at Barsebäck Kraft AB (BKAB) has gone down from 450 during operation of Barsebäck 1 and 2 to 52 employees involved in Service operation of both units. But still there are in total 130 persons placed at Barsebäck NPP with different kinds of job assignments.

DEMANDS FROM THE AUTHORITIES

The Decommissioning plan for Barsebäck NPP is based on current requirements from the Swedish Authority, Swedish Radiation Safety Authority (SSM).

The Swedish Authority requires that there should be a preliminary decommissioning plan when a nuclear installation is built. This plan will be in more detail before the final dismantling starts up. A new Safety Analyze Report has to be developed for the dismantling phase

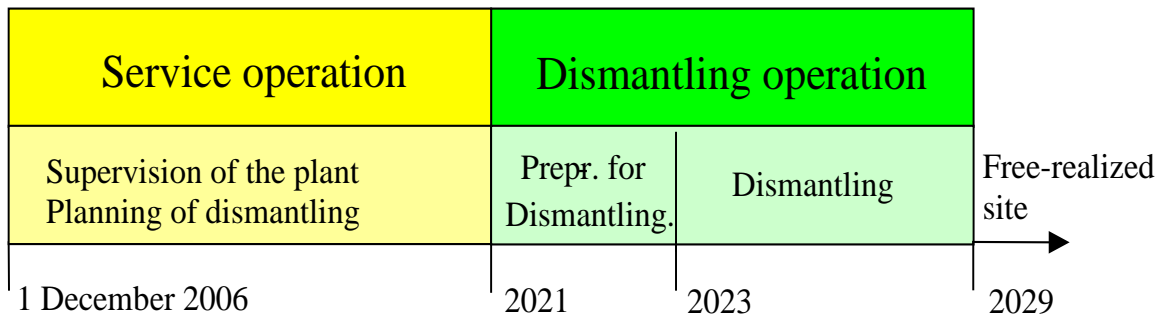
The Environmental Law in Sweden requires a court order from the Environmental Court, including an Environmental Impact Assessment, before the owner of a nuclear facility can start up the decommissioning of the plant. An EIA for Service operation have been sent in to the Court and the court order has given BKAB permission for Service operation until the repository is available.

STRATEGY

Owner of the Barsebäck NPP, EKS, have the future responsibility for dismantling of the NPP. There is an Agreement between EKS and BKAB, who works as an operator during the Service operation period. BKAB is a Vattenfall company and is owned by Ringhals AB, Vattenfall AB (100 %). Ringhals AB is owned by Vattenfall (70 %) and by EON Sverige AB (30 %).

Following strategies have been developed for the Service operation period and the Dismantling period of Barsebäck NPP (*Picture 3*):

- Decommissioning in according to the “Swedish system” (transportation and final storage of radioactive waste handled by SKB). This means that the final repository for the short-lived low- and medium-active dismantling waste, SFR, must be ready and in operation before dismantling begins. According to SKB: s plan the storage is in operation 2023.
- Dismantling of Barsebäck 1 and 2 will probably be carried out under a joint project.
- Service operation must be simple, safe and cost-optimized. This means placing the plant in the lowest energy mode, reducing the need for monitoring, minimizing residual safety risk and optimizing the cost of service operation and future dismantling.



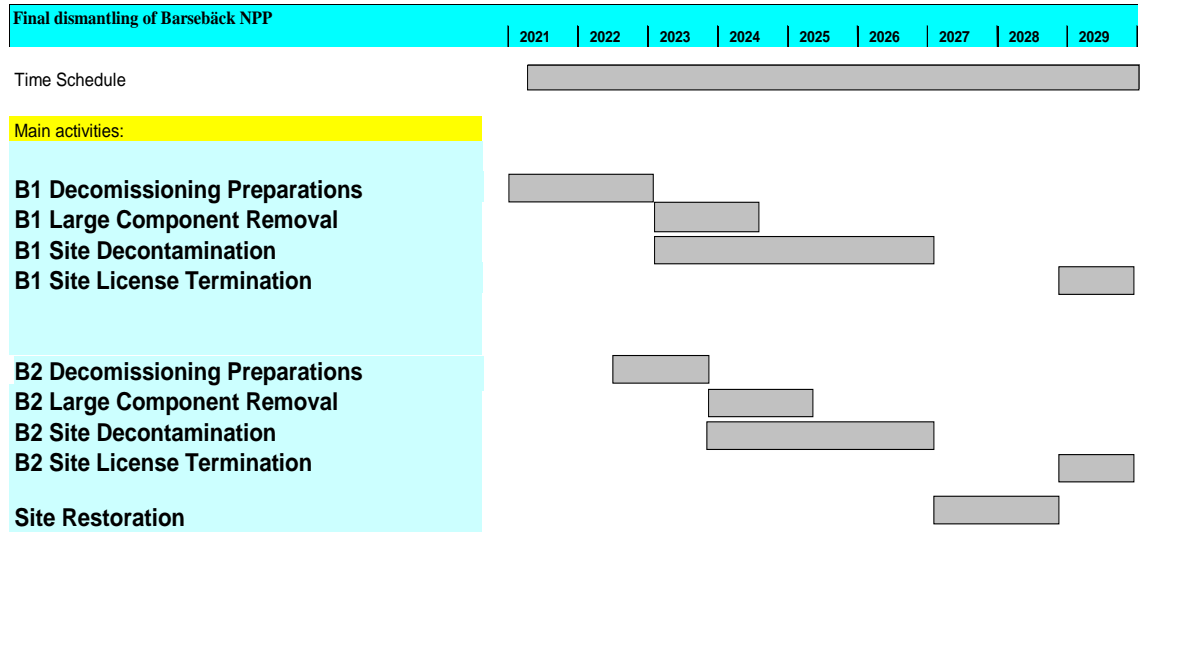
Picture 3 – Scenario for decommissioning of Barsebäck 1 and 2

BKAB: s approach for the dismantling are:

- **Safer** – Eliminate and reduce risks by system decontamination, start the dismantling by taking out big components, well-prepared steps, a Safety Analyze Report for dismantling.
- **Faster** – Create conditions for a flexible logistics by a detailed characterization, legal aspects fully analyzed, a good planning process, the process for each type of waste clarified in detail, the final repository for dismantling waste in operation.

- **Cost effective** – Focus on the time-schedule by planning for less than five years time for dismantling of the site. Focus on the end point of the project.

The end point of the decommissioning of Barsebäck NPP is that the plant should be declared free-released. It would then be up to the owner of the site (EKS) to decide what is to be done with the land in the future. (Picture 4)



Picture 4 Main Activities for Final Dismantling

The decommissioning project at Barsebäck NPP, today and in the future, will be an important experience for the whole Swedish Nuclear Industry.

MAIN ACTIVITIES THAT HAVE BEEN DONE

Following main activities have been done before and during Service operation:

- A project, RIVKRAV has identified, assessed and influenced the requirements for dismantling and demolition of Barsebäck NPP
- An overall decommissioning plan has been presented and accepted by the owner and the Swedish Authorities.
- All nuclear fuel have been transported away to the interim storage at CLAB in Oskarshamn
- Hazardous material such us turbine oil and chemicals has been removed from the site.
- A radioactivity survey of Barsebäck NPP has been carried out. Events that may have generated radioactive spillage into the installations of the Barsebäck plant have been analyzed.

- Inventory of existing documents has been done and continues.
- Barsebäck 1 has been used for an international R&D project, CONMOD (progressive ageing of the concrete in the containment).
- BKAB have built up contact nets and competence by taking part in different kind of national (SKB) and international missions (IAEA, OECD/NEA, EON Germany, EPRI)
- A new Management system, a new Safety Analyze Report (SAR) and a new Safety Technical Regulation (STF) for Service operation has been approved by the Swedish Authority.
- Reconstruction of the electricity systems and operation systems. The goal was to adapt the electrical systems for the demands and requirements of the Service operation and to create a site easier to survey and to reduce costs for operation and maintenance.
- Decontamination has been done, during 2007/2008, at Barsebäck 1 and 2 of the primary systems and the lower parts of the reactor vessels with an excellent result. The goal was to establish acceptable working conditions for the Service operation and to establish low dose rate status in the primary systems to make it possible to use simple techniques for dismantling, demolition and transportations in the future. The company AREVA's Cord method was used in co-operation with experts and equipments from Oskarshamn NPP (OKG). The Project received a decontamination factor on average of 293 for Barsebäck 1 and 93 for Barsebäck 2.
- The Central control room is unattended since 2007 and the supervision of the Service operation is handled by a system of duty engineers. A function as alarm operator has been established for the security personals at the security central and they take contact with the engineer when an alarm detects.
- Project Characterization. The goal was to characterize radioactivity in systems, buildings, soil, and groundwater and also analyze the rest of hazardous materials such as asbestosis.
- Studies are performed for removal of the whole reactor vessel in one part and for transportation to the final repository.
- Studies are performed for waste management and for demolition of buildings

MAIN ACTIVITIES DURING SERVICE OPERATION

Following main activities are planned to be done during the following Service operation period:

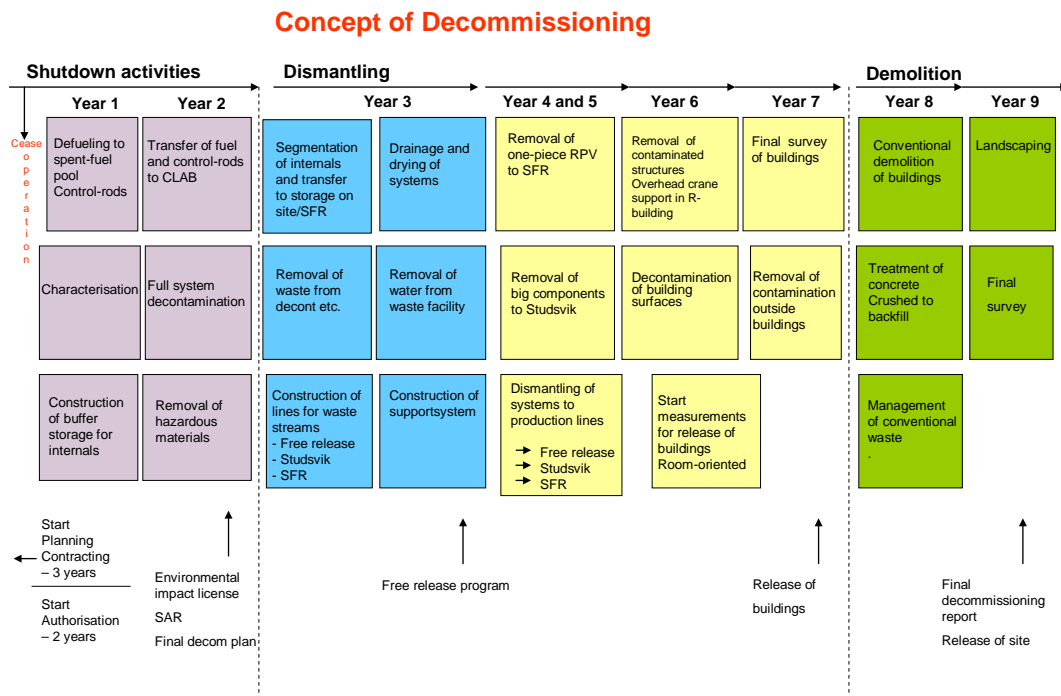
- The dialogue with the authorities on the set of requirements for dismantling and demolition continues.
- Segmentation of internal parts of the from the reactor vessel
- Continue to develop and update dismantling plans for Barsebäck 1 and 2
- Continue building knowledge through co-operation in national and international forum.

- Develop an Environmental Impact Assessment for the Dismantling period.
- Develop a new Safety Analyze Report (SAR) for the Dismantling period.

LESSONS LEARNED

Below brings out some important lessons learned from Barsebäck NPP decommissioning project:

- The requirements should be clear before starting up the dismantling and demolition project.
- An open dialog with stakeholders, building trust.
- A good planning process is important. If you have a small organization it is very easy to underestimate the needs from your own personal with knowledge from the sites construction.
- To create good working conditions on the site, do the system decontamination as early as possible.
- Have a system for overlapping of area of responsibility when employees leave the company.
- Updated documentation is vital during the whole decommissioning process.
- Mind setting from operation to decommissioning is a key to success. BKAB: s experience is that a former operation organization needs external helps from international experts.
- Identify the concept and the tricky parts in the project. Use international experience when you study the tricky ones. (Picture 5)



PICTURE 5 CONCEPT AND TRICKY PARTS