

Barsebäck NPP in Sweden – Decommissioning Project - 9350

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ABSTRACT

Barsebäck 1 and 2, type BWR (Boiling Water Reactor) with a capacity of 615 MWe was closed down permanently on 30 November 1999 respective 31 May 2005 due to political decision. Both units together have been in Service operation (Care and maintenance) since 1 December 2006.

Barsebäck NPP will stay in Service operation until beginning of 2018 when Dismantling operation begins with the aim of a free-realized site in the beginning of 2025. That means that the remaining buildings, including equipment should be declared free-released or dismantled. It would then be up to the owner, E.ON Kärnkraft Sverige AB (EKS) to decide what is to be done with the site in the future.

There was a re-organisation at Barsebäck Kraft AB (BKAB) in 1 January 2007 and the company is organised in the following areas of function: site service operation, decommissioning planning, new business and BO replacement.

The Organisation at BKAB has gone down from 450 during operation of Barsebäck 1 and 2 to 50 employees (2009-01-01) involved in Service operation of both units. But still there are in total 250 persons placed at Barsebäck NPP with different kinds of job assignments.

A lot of activities have been carried out since 2000 and up to now for example:

- All nuclear fuel has been transported away to interim storage at CLAB in Oskarshamn.
- BKAB have built up contact nets and competence by taking part in different kinds of national and international organisations (SKB, IAEA, OECD/NEA TAG, WNA, ENISS, WANO, EPRI etc) commissions.
- The Electrical and operational systems have been rebuilt for the actual demands and requirements for the Service operation.
- The central control room is unattended since 17 December 2007 and the supervision of the Service operation is handled by a system of VDI (duty engineers) and LOP (alarm operators).
- Full system decontamination on unit 1 and 2

Barsebäck's approach today and for the future dismantling are:

- Safer
- Faster
- Cost effective

BKAB's strategies and approaches for decommissioning will be an important experience for the whole Swedish Nuclear Industry, and we are convinced that we have and also could create opportunities to fulfil these approaches.

INTRODUCTION

Barsebäck NPP is owned by E.ON Kärnkraft Sverige AB (EKS), a subsidiary of E.ON 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
Licence holder	BKAB
Operator	BKAB
Production	Total 93,4 TWh net(1999)/ 108 TWh net (2005)
Status	Permanently shut down since 30 November 1999/ 31 May 2005
Operating status	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

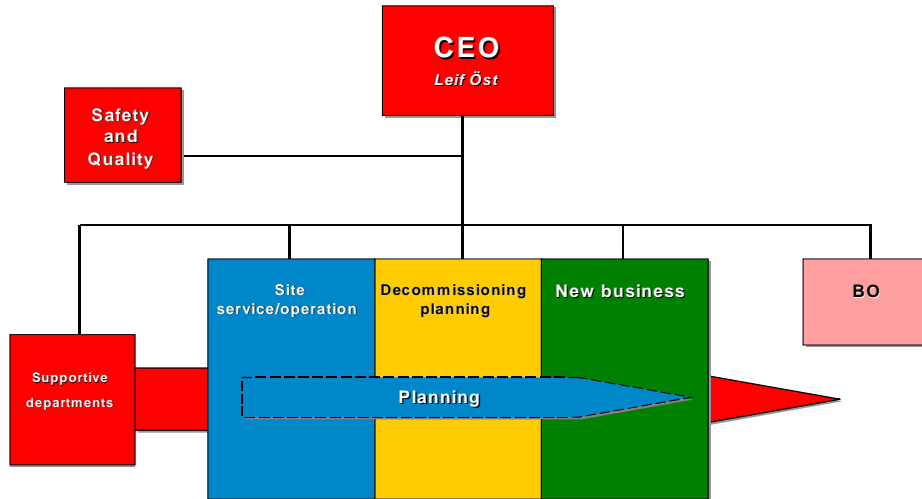
Barsebäck 1 was closed permanently on 30 November 1999 and Barsebäck 2 on 31 May 2005. Both closures were due to political decisions.

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.

For more details about the history please read the document “*Barsebäck NPP in Sweden – Transition to Decommissioning Socio-Economic aspects of Decommissioning*” (9092).

BKAB's ORGANISATION 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 the 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 create long-term 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, stores, workshops, hotels offer services and competence (as an example service for E.ON Gas turbines), sell components and equipment.
- **BO – Barsebäck replacement department** – This department gives support to staff during the 3 years of employment guarantee to turn over new employment/occupations.

The Organisation at Barsebäck Kraft AB (BKAB) has gone down from 450 during operation of Barsebäck 1 and 2 to 50 employees (2009-01-01) involved in Service operation of both units. But still there are in total 250 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 Radiation Safety Authority (SSM).

SSM 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.

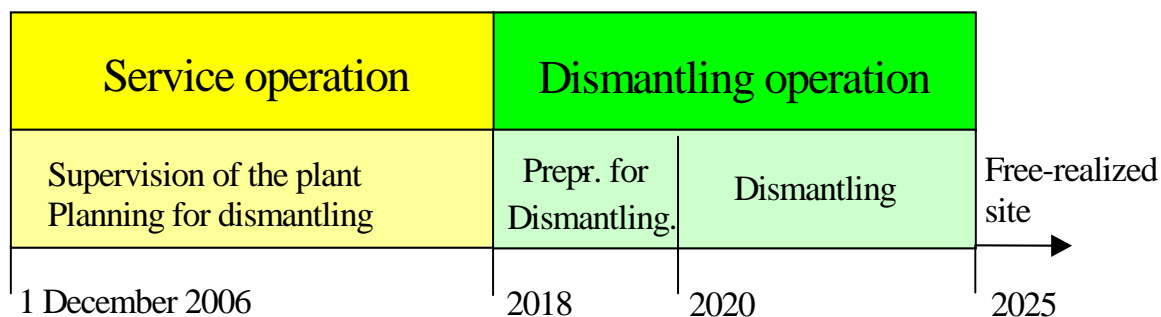
The Environmental Law in Sweden requires a court order from the Environmental Court, including an Environmental Impact Assessment, before the owner of a nuclear facility can start up the decommissioning of the plant. An EIA for Service operation have been sent in to the Court during 2006 and the court order has given BKAB permission for Service operation until 2012. There have to be a new applicant for a license for 2013 up to 2017 for the remaining Service operation period.

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 (100 %). Ringhals AB is owned by Vattenfall (70,44 %) and by E.ON Sverige AB (29,56 %).

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, SFR3, must be ready and in operation before dismantling begins. According to SKB:s plan the storage is in operation 2020.
- 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.



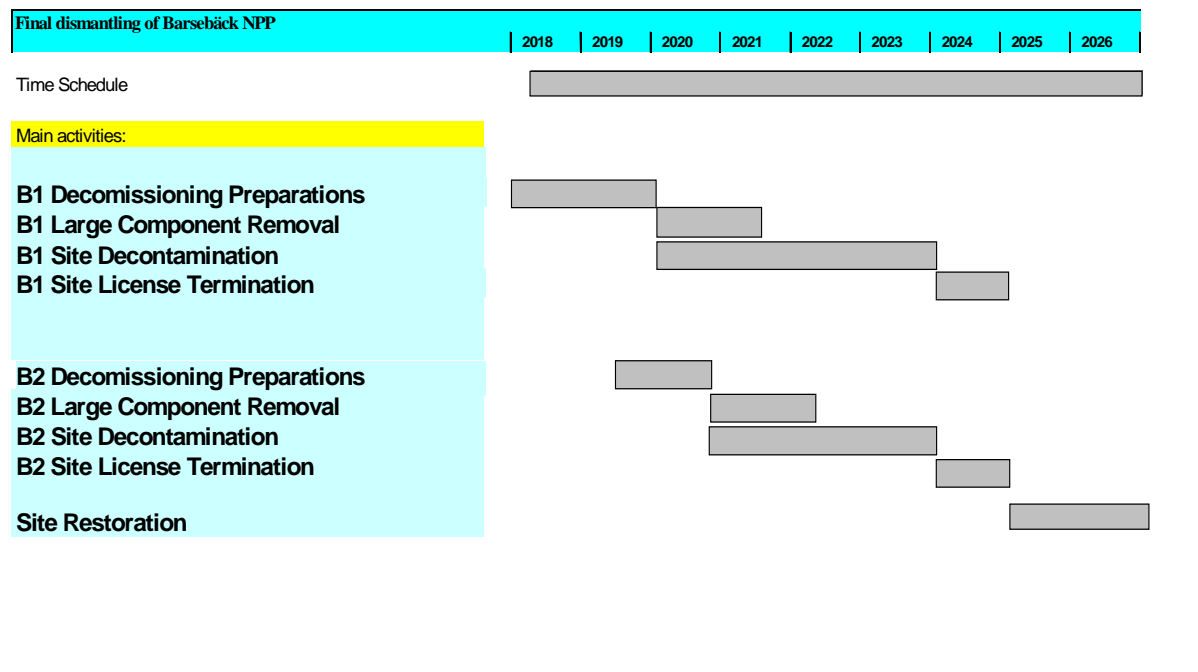
Picture 3 – Scenario for decommissioning of Barsebäck 1 and 2

BKAB:s approach for the dismantling are:

- **Safer** – Eliminate and reduce risks by a system decontamination, start the dismantling by taking out large 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 storage facility 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 a free realized site for reuse.

The ultimate aim of the decommissioning of Barsebäck NPP is that the remaining buildings of the plant, including equipment, should be declared free-released or dismantled. It would then be up to the owner of the site (EKS) to decide what is to be done with buildings and the land as a whole (*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.

BKAB`S INTERNATIONAL CO-OPERATION ON DECOMMISSIONING

There was a re-organization of BKAB during the first half-year of 2000. The company was organized in one supervision department for unit 2 still in operation and one decommissioning department for unit 1. This was important according to international sk. Lessons learned to have different kinds of focus. The employees at unit 1 handled the supervision (with help from control room`s staff from unit 2) of the site and also planning for the future dismantling of both units.

One important mission for the department of unit 1 was to build up national and international network and knowledge for decommissioning including the future dismantling. The mission was to:

- Capture experience both national and international
- Follow dismantling projects around the world

- To create conditions to reduce life-time costs
- Create a contact network with national and international organizations, authorities, power plants, experts, consulting and contracting companies and others
- Participate in national and international activities

BKAB's international activities have focus on influence of requirements and experience and influence of D&D.

On influence of requirements BKAB are working pro-actively with following organizations:

IAEA

Ongoing activities:

- Project FaSa – Safety Analyses during a facility Life cycle.
- Membership in IAEA IDN – International Decommissioning Network

Example of previous activities:

- Project DeSa, there Barsebäck NPP was one of the Test cases.
- Taking part in different kinds of expert groups in producing Safety Reports and Technical Reports
 - Safety Reports series no 31 – Managing the Early Termination of Operation of Nuclear Power Plants
 - Technical Reports 411 – Record Keeping for the Decommissioning of Nuclear Facilities: Guidelines and Experience
 - Technical Reports 420 – Transition from Operation to Decommissioning of Nuclear Installations
 - Technical Reports 464 – Managing the Socioeconomic Impact of the Decommissioning of Nuclear Facilities
 - Guide for the preparation of policies and strategies for the Decommissioning of Nuclear Facilities (draft version)

WNA – World Nuclear Association

Membership in WG Radiation Protection and WG Waste Management & Decommissioning

Ongoing activities:

- Making influence on documents from IAEA RASSC and WASSC fore example the IAEA reviewed BSS – DS379 and DS 284

Example of previous activities:

- Comments on ICRP new framework and IAEA Documents,
- Producing WNA Position Statements on Safe Decommissioning of Civil Nuclear Industry Sites and WNA Position Statement on Removal from regulatory control of material containing radioactivity – Exemption and clearance.
- Seminar on recycling and re-use of material

FORATOM – ENISS

BKAB is a member of ENISS – European Nuclear Installations Safety Standards – Waste/Decom Safety Group

Ongoing activities:

- Making influence on on-going documents from IAEA RASSC/WASSC, WENRA Safety Reference level reports, ENEF European Nuclear Energy Forum. Example of on-going documents are IAEA DS 379, DS 284 and DS 416

Example of previous activities:

- Comments on WENRA Decommissioning Safety Reference Level Report
- Comments on IAEA Safety Assessment for Decommissioning of Nuclear Facilities DS 376

On experience and influence of D&D BKAB are working pro-actively with following organizations:

OECD/NEA

BKAB are a member of the CPD TAG (Technical Advisor Group) (2008-2014). This group consists of world wide ongoing Decommissioning projects from NPP:s and Research Reactors sharing Lessons Learned from the projects. The Group has workshops meetings twice a year were the member's present's progresses from the last six months. There are also presentations on a specified topic fore example characterization, free realize of soil and groundwater there the members can share their experiences.

BKAB participate in different kinds of sk. Task groups. Two groups have recently started up, Disposal of large components and R&D of Decommissioning techniques.

EPRI

BKAB is a member of the Decommissioning Technology Program (2008-2010). The purpose with the program is to minimize the cost and risks of decommissioning trough enhanced planning, applying lessons learned by other utilities.

Ongoing activities:

- During 2008 we have started up support from EPRI consulting experts in the Characterization project (project KAKA) and BKAB Decommissioning planning process.
- BKAB and EPRI are planning for a workshop in Sweden during 2009 with a focus of the Requirements for the future dismantling of Barsebäck NPP.

OTHER MAIN ACTIVITIES THAT HAVE BEEN DONE:

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

- An overall Decommissioning plan has been presented and accepted by the owner and SSM.
- All nuclear fuel have been transported away to interim storage at CLAB in Oskarshamn
- Hazardous material such us turbine oil and chemicals has been taken away 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.
- Some preventive maintenance has been switch to corrective maintenance.
- 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).

- A new Management system, a new Safety Analyze Report (SAR) and a new Safety Technical Regulation (STF) for Service operation has been created and approved by the Swedish Authority, SSM.
- Project ANPEL. Rebuilding of the electricity systems and operation systems. The goal was to adjust the electrical systems for the actual demands and requirements for the Service operation and to create a site easier to survey and to reduce costs for operation and maintenance.
- Project Decontamination. Decontamination has been done, during 2007/2008, at Barsebäck 1 and 2 of the primary systems and the lower parts of the reactor tank 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 17 December 2007 and the supervision of the Service operation is handled by a system of duty engineers (VDI). VDI is on duty during 24 hours per day. A function as alarm operator (LOP) has been established. Guarding personals from the Guarding central (BC) serve as a LOP and take contact with VDI when an alarm goes. After that it is VDI:s responsibility to make the right decisions and steps. BC is staffed 24 hours per day.

MAIN ACTIVITIES DURING SERVICE OPERATION

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

- Continue to prove and make influence of new regulations both international from IAEA and EC and national from the Swedish Authorities mainly SSM. SSM is just now preparing a new regulation for free-release of material, locals and building built on international recommendations from IAEA and EC. The owner of the Swedish nuclear facilities has sent in their comments to SSM on a submission concept. The owners representatives are now writing a sk. "Code of practice", like the one in UK, to meet the new demands of nuclide specific measurement and lower free-realize levels. BKAB have stated up a minor project group (project RIVKRAV) to analyze Swedish laws and regulations that have influence on the future dismantling on Barsebäck NPP. The Groups purpose is also to find out any gaps were there is lack of needed regulations and start up a pro-active process with the Swedish Authorities to fill these gaps. Time schedule for the project is 2009 up to 2012.
- Project Characterization will start up in February 2009. The goal is to characterize radioactivity in systems, buildings and ground and also analyze the rest of hazarders' materials such as asbestosis.
- An ongoing analyzes is looking at possibilities and alternatives to take out the hole reactor tank in one part and deliver it to SKB for transportation to the final storage. During 2009 there will be a parallel analyzes of segmentation of the reactor tank.
- Disposal of operational waste stored on site. Core grids from the operational period are stored on site in pools waiting for approved transportation cask and sent to a national interim storage. This interim storage is planed to be in operation 2012 and the core grids are planed to be stored here until the final deep repository is in operation 2045. Ion exchanger masses from the operational period are

stored in tanks at the Barsebäck site. New equipment has been installed at Barsebäck NPP to solidify these masses in concrete. After a process for acceptance from the Authorities we now can start the solidification during 2009 and it takes approx. 7 years to finish.

- Continue to create and up-date dismantling plans for Barsebäck 1 and 2
- Supervision and maintenance to reduce the total operating maintenance costs of the Barsebäck plant. This means to analyze preservation of systems and components, maintenance costs tie to new purchase to the schedule with a long period of Service operation and thereafter the following final dismantling. This also means to optimize energy consumptions via electricity, gas, water and ventilation system.
- EIA for extension of Service operation 2013 up to 2017
- EIA for the Dismantling operation period.
- New Safety Analyze Report (SAR) for the Dismantling operation period.
- The overall planning to day bears the stamp of a great number of different preliminary studies. These studies must be put together in due time to a basis of the decision for the owner of the plant, EKS to start up the projecting of the final dismantling of Barsebäck NPP at the later half of the Service operation period.

LESSONS LEARNED

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

- The re-organization during 2000 when Unit 1 and its employees focused on Decommissioning and Unit 2 focused on supervision was important to maintain safety and cost optimization on the site.
- To have a social and economical program for the employees is important.
- An open dialog with stakeholders, as an example the Authorities, creates confidence.
- The optimal way to prove and to make influence on new regulations from the National authorities is to start that process early on the international arena, IAEA and EC.
- A good planning process is most important. If you have a minor organization it is very easy to underestimate the needs from your own personal with vital knowledge from the sites construction. Barsebäck found out that some key electrical personal was needed in some project ongoing at the same time. Do a good analyze of the projects and do not miss to compare them to find out if there are any overlaps of key personals.
- To create good working conditions on the site there is a profit to do system decontamination as early as possible.
- Before staffs with experience and knowledge over historical events leaves the company do an inventory.
- Have a system for overlapping of area of responsibility when employees leave the company.

- Updated documentation is vital during the whole decommissioning process. There can be a lot of useful information's in sk. Private archives.
- Mind setting from operation to decommissioning is a key to success. BKAB:s experience is that an former operation organization needs external helps from international experts.
- If you are going to use a site that has closed down permanently during a period of Service operation for new business there can be a conflict between placing the site in the lowest energy mode. If you have two units use perhaps only one unit for new business.
- Clear the site from hazardous material as soon as possible. It is vital for the Safety Analyze Reports that have been don for the Service operation.
- Have opened mind for experience, co-operation in national and international forums to share sk. Lesson Learned.

REFERENCES

1. LORENTZ/PÅLSSON, "The Decommissioning plan for Barsebäck NPP" (Darwin 1884576), 2008