Report 2007:7e from the Swedish National Council for Nuclear Waste

KÄRNAVFALLSRÅDET
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STATENS OFFENTLIGA UTREDNINGAR

Decommissioning of Nuclear Facilities in Sweden

A report from the Council's hearing on December 2007

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The report is availible in digitalform at www.karnavfallsradet and can also be ordered in a printed version from the Swedish National Council for Nuclear Waste´s secreteriat

Translated into English by Richard Nord Translations AB
Cover: Miljöinformation AB
Cover photo: Pix Gallery/Sigge Persson

EDITA VÄSTRA AROS
Stockholm 2008
ISSN 1653-820 X

Preface

Decommissioning of nuclear power plants has become topical now that both reactors in Barsebäck have been shut down. The combined heat and power plant in Ågesta is still standing, despite the fact that 30 years have passed since it was taken out of service. Both of the research reactors in Studsvik were shut down in 2005.

At the same time, the nuclear power industry has, via the Swedish Nuclear Fuel and Waste Management Co (SKB), said that decommissioning cannot be commenced until sometime after 2015, and probably not until the early 2020s (RD&D Programme 2004). This has been criticized in particular by Kävlinge Municipality, backed by KSO (the Cooperation Organization of the Nuclear Power Municipalities). The Swedish Radiation Protection Authority said in its statement of comment on RD&D Programme 2004 that decommissioning should take place as soon as it is reasonably possible after cessation of operation. The Swedish National Council for Nuclear Waste found in its review of RD&D Programme 2004 that SKB's and the reactor owners' planning now needs to be further concretized, that a critical review is needed of the cost calculations presented to date, and that issues associated with environmental impact assessments prior to the decommissioning of the nuclear power plants need further illumination.

The Swedish National Council for Nuclear Waste therefore held a hearing on 11 December 2007 as a part of the Council's knowledge accumulation regarding issues concerned with the decommissioning and dismantling of nuclear installations. The hearing was a part of the Council's transparency programme[1]. Some of the topics that were discussed were:

[1] The Swedish National Council for Nuclear Waste's transparency programme was initiated in the autumn of 2006 for the purpose of accumulating knowledge and strengthening the Council's role as an advisor to the Government by shedding light on strategic issues. The

- the owner's plans for decommissioning of the Barsebäck plant,
- SKB's plans for managing and disposing of the radioactive waste and the requirements of the supervisory authorities,
- the concerned municipalities' needs and viewpoints,
- costs and financing,
- the decision process including the EIA procedure.

This hearing was the second in a series of seminars and hearings within the framework of the transparency programme. A programme for future transparency hearings is available on the Swedish National Council for Nuclear Waste's website at www.karnavfallsradet.se.

transparency programme should also serve as a resource for other stakeholders in the future licensing process.

Contents

1 Financing system for decommissioning and dismantling

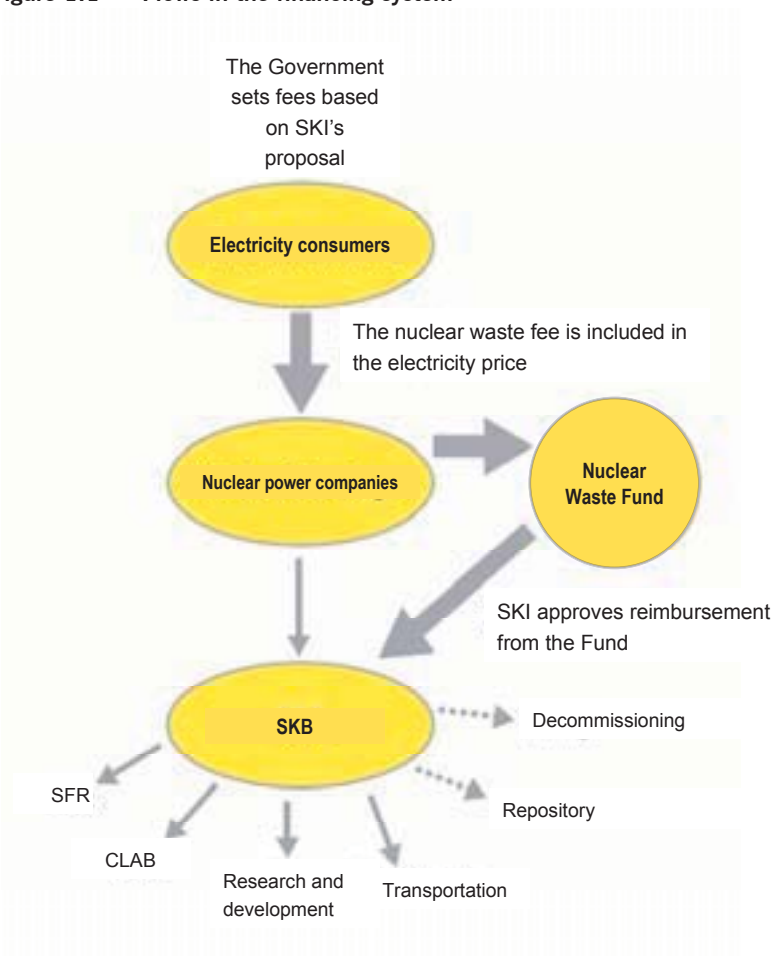
Staffan Lindskog, SKI

After the national referendum in 1980 on the future of nuclear power, it was decided how the Swedish financing system for decommissioning and dismantling of nuclear power plants was to be designed. The legislation regarding how much time the nuclear power plants have to earn the costs for decommissioning and dismantling was amended as from 1 January 2008. The previous earning period of 25 years was extended to at least 40 years plus an additional 6 years.

Staffan Lindskog describes the structure of the financing system. The electricity consumers pay a fee for nuclear-generated electricity which is collected by the nuclear power companies via their electricity bill. The companies pay the amount into the Nuclear Waste Fund, a national authority that manages the money via the Legal, Financial and Administrative Services Agency. SKB calculates how large the fee should be in order to cover the costs of final decommissioning. After SKI has reviewed SKB's background material, SKI presents a proposal to the Government, who makes the final decision on the size of the fee. Previously a decision on this has been made every year, but in the future decisions will be made at three-year intervals. The next year for such a decision is 2010.

SKB uses money from the Fund for R&D, storage of operational waste, transportation, development and construction of a final repository for spent nuclear fuel, and decommissioning of the nuclear power plants. SKB requisitions money from the Fund and SKI makes decisions on allocation.

Figure 1.1 Flows in the financing system



Why decommission at all?

The reason why the nuclear power plants have to be decommissioned at all is the induced radiation. Otherwise the plants could be allowed to stand until it was commercially profitable to decommission them, says Lindskog. But there are other important principles that require decommissioning and dismantling. One is the principle that he who makes the mess is also responsible to clean it up. A fundamental principle for the financing system is therefore that

estimates of the costs for decommissioning, shutdown and dismantling should be based on the Polluter Pays Principle, or PPP.

"Another important principle is that the costs should not be passed onto future generations so that their standard of living is curtailed," says Lindskog.

Estimated costs of decommissioning

Every nuclear power plant calculates individually what it will cost to decommission and dismantle the plant, but SKB coordinates the work. The industry figures that decommissioning costs about SEK 1 billion per reactor (slightly less for a research reactor). At today's prices, the costs of decommissioning are estimated, according to Lindskog, to amount to:

- Forsmark SEK 4.3 billion
- Oskarshamn SEK 3.8 billion
- Barsebäck SEK 2.6 billion
- Studsvik's research reactor SEK 0.6 billion

Staffan Lindskog says that good estimates of the costs are needed because the industry and the electricity customers do not want to pay too much for something that could be done less expensively, while on the other hand if there is too little money in the Fund the quality of the decommissioning work will suffer. Too low quality is a potential threat to human health and the environment.

"If there is not enough money for decommissioning, future generations may be forced to pay for it, or the decommissioning will be done at a less suitable time or not at all. A combination of the above effects is also possible," he says.

The Government on RD&D 2004

The question of decommissioning is raised in the RD&D programmes which SKB publishes every three years. The Government's decision following the review of RD&D 2004 says that SKB should intensify its work with decommissioning. According to Lindskog, the will to intensify this work exists not only in Sweden,

but in the whole of the EU, and it is estimated that approximately a hundred nuclear power plants will be shut down throughout the Union by 2020. Many of them are in France, but the shutdowns are being done for commercial reasons even though the country is continuing its nuclear power programme.

In the RD&D decision, the Government said that SKB and the reactor owners should explore the possibility of carrying out parts of the dismantling work earlier than planned. Furthermore, the Government said that SKB should investigate how soon it will be possible to begin the licensing process for the final disposal of decommissioning waste. SKI and SSI concur.

According to Lindskog, the Swedish Financing Act is a pioneering piece of legislation. Many countries have used the Swedish system as a model, for example Spain, which has developed it further. Other countries such as Slovakia have instead copied the old Swedish system.

International organizations on financing of decommissioning

There are international supportive documents for decommissioning. For example, the European Commission has issued recommendations on the management of financial resources for the decommissioning of nuclear installations, spent fuel and radioactive waste.

The IAEA and NEA recommend that countries give early thought to the fact that funds must be allocated at the beginning of the planning chain, starting with the design of the nuclear power plants.

Financial provisions must also be made in the event that early shutdown of the nuclear power plants is necessary. Such early shutdown may be necessitated by accidents, but may also stem from commercial or political considerations. The financing mechanism needs to be sufficiently robust to cope with this.

SKI funds research

SKI funds supportive research aimed at providing material as a basis for reviewing costs and enabling SKI to recommend fees to the Government. Background material is also compiled as a basis for planning by the regulatory authorities and for future work having to do with nuclear safety and radiation protection.

"We also fund research to ensure that the cost calculations carried out by the Swedish nuclear industry conform to international practice and to bring about an active learning process," says Lindskog. He also points out that SKI funds comparative studies where calculations of future decommissioning costs are compared with authentic decommissioning costs from similar facilities.

SKI's review of the decommissioning costs

SKI's future challenges consist in carrying out evaluations of the decommissioning costs. Since the evaluations are comprehensive they will require 8–10 years of work. The decommissioning costs will be included in the RD&D process, and the next two accounts from SKB will come in 2010 and 2013. For this reason the actual decommissioning costs will not be addressed by SKI until the Inspectorate's Plan 2011 and Plan 2013.

According to Lindskog, the costs for decommissioning are closely linked to the radiological contamination, which therefore needs to be surveyed.

"We need to see which technique is needed and how much time decommissioning and dismantling will take, as well as what volume is needed for e.g. disposal. The final cost is thus highly dependent on which approach is chosen, and then it is the choice of decommissioning technology that is crucial," says Lindskog.

The cost calculations are carried out regularly every three years. The calculations should also be done individually, per facility. The cost calculations for decommissioning and final disposal should furthermore be kept separate. Lindskog concludes by saying that SKI cooperates in international forums for development of uniform principles for cost calculations.

2 Swedish legislation governing the decommissioning of nuclear power plants

Ingvar Persson, SKI

The legislation governing nuclear activities is essential in a situation where the nuclear power plants are to be decommissioned and dismantled. Ingvar Persson gives an account of the applicable Swedish statutes, namely the Environmental Code, the Nuclear Activities Act, the Radiation Protection Act and the Nuclear Power Phase-Out Act, which are described in greater detail below. For the sake of completeness he also mentioned the Euratom Treaty, but no licensing is required under this treaty. According to Article 37 of the treaty, the member states only need to describe their plans and give other member states an opportunity to state their viewpoints.

Swedish legislation concerning decommissioning of nuclear facilities

Environmental Code (1998:808)
– Ordinance concerning Environmentally Hazardous Activities and Health Protection (1998:899)
– Ordinance on Environmental Impact Assessments (1998:905)

Act on Nuclear Activities (Nuclear Activities Act)
– Swedish Nuclear Power Inspectorate's Regulations concerning Safety in Nuclear Facilities (SKI's 2004:1)

Radiation Protection Act (1988:220)
– Swedish Radiation Protection Authority's Regulations on Planning for and during Decommissioning of Nuclear Facilities (SSI FS 2002:4)

Definitions used in connection with decommissioning and dismantling

SKI and SSI define decommissioning in similar ways, but while SKI's definitions relate to the technology, SSI's focus on radiation protection.

SKI's definition of decommissioning: measures adopted by licensees after the final shutdown of a facility in order to dismantle and demolish the facility in a safe manner and to manage the nuclear material and nuclear waste at the facility site (SKI's regulations SKIFS 2004:1).

SSI's definition of decommissioning: collective term for the actions taken by the licensee after final shutdown in order to reduce the amount of radioactive substances in land and buildings to levels that allow the release of the site (SSI's regulations SSI FS 2002:4).

Defuelling operation refers to the part of the decommissioning period when nuclear fuel is still present in the power plant (Gov. Bill 1992/2000:63 p. 19).

Nuclear Activities Act

The Nuclear Activities Act governs nuclear activities. The Act uses the expression "nuclear activities" as a collective term for what it covers. The term is of central importance for the systematics and scope of the law and is particularly important because it is not permitted to conduct nuclear activities without a licence. The licence applies only to the licensee and no one else. This means it is not permitted to transfer a licence to another actor without first obtaining approval from the Government according to the Nuclear Activities Act.[1]

[1] The Act therefore also constitutes a duty for the licensee to obtain special approval before an assignment can be given to a contractor.

A licence confers the right to own and operate a nuclear facility. But the licence also carries a number of obligations. The obligations include not only upholding safety but also ensuring that nuclear waste arising in the activities and nuclear material that is not reused can be managed and disposed of in a safe manner. The obligations also include ensuring that a facility in which activities are no longer to be conducted is decommissioned and dismantled in a safe manner. This entails complete dismantling and removal of the reactor and other devices included in the reactor plant.[2]

The final disposal issues are directly connected to the provision in Section 14 of the Nuclear Activities Act on the long-term obligations of the licensee. The provision also states that even if a licence has been revoked or expired, the licensee is still obliged to safely manage and dispose of spent nuclear fuel and nuclear waste and to decommission and dismantle the plant. This responsibility persists until the obligations have been fulfilled or the Government has granted exemption from them.

Obligations have not been fulfilled until the plants have been dismantled or released for unrestricted use and all nuclear material and nuclear waste has been emplaced in a final repository that has been closed. A licence to conduct nuclear activities is thus a long-term undertaking.

"The provisions of the Nuclear Activities Act entail that the licence to own and operate a nuclear installation may persist for many decades after the activities have actually ceased," says Persson.

He points out that there is, however, no requirement under this Act on having a permit to decommission a nuclear facility. And since a facility that is to be decommissioned is still to be regarded as a nuclear facility, the regulatory authorities have to continue to supervise the activity and can also stipulate conditions and issue regulations with regard to safety and radiation protection. This may entail stipulating requirements on how the facility is to be decommissioned.

[2] Gov. Bill 1984/84:60 p. 90 ff.

Environmental Code

A permit to decommission a reactor is, however, required under the Environmental Code. The permit requirement applies from when a reactor is shut down until the reactor has ceased to exist due to the fact that all nuclear fuel and other radioactively contaminated material has been permanently removed from the facility site. This means that all fuel and radioactively contaminated material must be removed. Only then does the reactor cease to exist.[3]

The environmental court decides on permits. In conjunction with the decision the court can also stipulate conditions for the permit. For example, the environmental court in Växjö stipulated certain requirements for the for the shutdown operation of Barsebäck's reactors.

It is assumed under the Environmental Code that decommissioning and dismantling a reactor always leads to considerable environmental impact. That is why an environmental impact assessment has to be carried out[4]. The permit applicant must consult with national authorities, as well as with municipalities, private citizens and organizations that are likely to be affected. The consultations shall cover the siting, scope, design and environmental impact of the planned activity, as well as the form and content of the EIS. The documentation surrounding the consultations shall be made available so that private citizens can offer viewpoints, which shall in turn serve as a basis for the standpoints adopted by the environmental court.

Radiation Protection Act

The purpose of the Radiation Protection Act is to protect humans, animals and the environment against the harmful effects of radiation. The Act applies to both ionizing and non-ionizing radiation.

The Radiation Protection Act is thus a protective act that regulates what is called "activities involving radiation". Such activities include e.g. ownership and operation of nuclear facilities.

The Nuclear Activities Act and the Radiation Protection Act are applied in parallel to nuclear activities. The Nuclear Activities

[3] Appendix A e 85/337-1 45 10 of the Environmental Code, which is based on the EU rules in the directive on environmental impact assessments.
[4] According to Chap. 6 of the Environmental Code.

Act regulates safety while the Radiation Protection Act regulates radiation protection. With the support of these laws, a division has been made between SKI and SSI and the legislation has been coordinated.

Special permits for nuclear activities are normally not required under the Radiation Protection Act.[5] However, conditions and regulations that are needed for radiation protection are regulated with the support of the Radiation Protection Act.

The Act is a framework law and is given its concrete content in many cases by regulations issued by SSI. When it comes to decommissioning of nuclear power plants, the main issue is ionizing radiation.

Both SKI and SSI have issued regulations governing dismantling and demolition. These entail that the licensee shall submit a decommissioning plan that shall be incorporated in the safety analysis report for the facility. The report shall be reviewed and approved by the regulatory authorities.[6]

Nuclear Power Phase-Out Act

The Nuclear Power Phase-Out Act is an expropriation law that has so far only concerned the reactors in Barsebäck.

With the support of the Act, the Government can decide that the right to operate the reactor for the purpose of generating nuclear energy shall cease to apply at the time designated by the Government. The Nuclear Power Phase-Out Act does not require that the Government's decision shall be based on an environmental impact statement. Since it is an expropriation law, the state is obliged to pay compensation for the loss incurred by the licensee as a result of the closure decision.

"The Government's decision under the Nuclear Power Phase-Out Act entails only that the right to operate a nuclear reactor for the purpose of generating nuclear energy is revoked. The licence under the Nuclear Activities Act continues to remain valid until

[5] There is a special provision on this in Section 27 of the Radiation Protection Act that says that if a licence has been issued pursuant to the Nuclear Activities Act or during the period of validity of the permit, the Government or the authority appointed by the Government may issue the additional conditions that are needed with respect to radiation protection. The Government has delegated the authority to examine matters relating to conditions according to Section 27 of the Radiation Protection Act to SSI.

[6] SKI's regulations SKIFS 2004:1 Chap. 9 Sec. 2 and SSI's regulations SSI FS 2002:4 Sections 9 and 10.

the licensee has fulfilled his obligations under the Nuclear Activities Act," says Persson. These obligations include complete dismantling and removal of the reactor and other devices included in the reactor plant. These obligations persist until all nuclear material and nuclear waste has been emplaced in a final repository that has been closed.

SKI on the decommissioning of the Barsebäck reactors

In conclusion, Ingvar Persson also gives an account of SKI's standpoints when the Inspectorate gave its opinion on the decommissioning of the Barsebäck reactors to the environmental court:

- Decommissioning of the nuclear reactors should not be commenced until suitable final repositories are available with permits for decommissioning waste from nuclear facilities.
- In order that the best available technology can be used for final disposal of the decommissioning waste, it should be conditioned and packaged with a view to the environment that will exist in the final repository.
- No interim storage facilities or final repositories for the decommissioning waste currently exist.
- No funds for building an interim storage facility for the decommissioning waste from the nuclear power plants are currently set aside in the Nuclear Waste Fund.

3 Questions and discussion concerning Lindskog's and Persson's presentations

Cost calculations

"How does SKI review the decommissioning cost calculations?" wonders Eva Simic. "Are the calculations carried out in cooperation between the industry and SKI or does each actor have its own calculation model?"

Staffan Lindskog replies that a joint system for probabilistic calculations has been developed. Monte Carlo simulations are being carried out of 64 projects, where each project corresponds to a medium-sized or large industrial project and 30 of them concern decommissioning. For the first time this year there is a separate report for each reactor owner. The method was developed in Sweden and is considered abroad to be cutting-edge.

Are the costs for decommissioning lower in Sweden than in other countries?

According to Eva Simic it is common that decommissioning of nuclear power plants is calculated to cost more in other countries than in Sweden. She wonders what the regulatory authorities think of this. Have the authorities carried out decommissioning studies, and if so what do they show? Are the industry's calculations correct with regard to the estimated costs of decommissioning Swedish nuclear power plants?

Staffan Lindskog, who works at SKI with calculations of the costs for decommissioning nuclear power plants, replies that different ways of calculating are used in different studies, so the

results are also different. Joint international projects are being carried out, for example within the OECD-NEA, on the development of methods and techniques for decommissioning studies.

"There is a great deal to learn in the EU, and we will eventually get the results of decommissioning projects in the former Eastern Bloc countries that have been funded by the EU, such as Ignalina. We will have to wait and see what these projects can teach us," he says.

SSI has made certain comparisons regarding research reactors. But, says Staffan Lindskog, it is difficult to make comparisons between Swedish and foreign studies because the costs have been distributed in different ways. It is therefore impossible to say that Swedish costs are significantly lower than, for example, French costs. The French power company EDF is working with test drawings of seven type reactors and will publish a report in two years, where comparative data will also be presented. He says that the OECD-NEA, in cooperation with other international bodies, is trying to bring about a uniform treatment of data and develop some kind of chart of accounts for decommissioning of nuclear power plants. If more countries use this, we will have more comparative material in the future.

Did the Government want to have a study about earlier dismantling in 2004?

Harald Åhagen thinks that the two SKI representatives, Staffan Lindskog and Ingvar Persson, are presenting different interpretations of what SKI considered to be the Government's decision concerning the RD&D process in 2004. Did the Government express there that SKB should study a quick dismantling of the Barsebäck plants? he wonders.

"Staffan Lindskog's interpretation of the Government decision is that SKB was supposed to intensify the work of examining the possibilities of earlier dismantling and shed light on the licensing process for this. Ingvar Persson, on the other hand, says that the material submitted to the environmental court in principle says that they will wait until SFR-3 is built. Then consideration should be given to treatment of the waste so that the waste packages are optimized to the environment in the final repository. This really discounts the possibilities of interim storage," says Åhagen.

Staffan Lindskog replies that the Government's RD&D decision in 2004 said that one reporting station should be scheduled for 2007 and that a more complete report should be submitted by RD&D 2010. SKI's review of RD&D 2004 entailed that the Inspectorate concluded that an interim storage of decommissioning waste should be avoided for economic reasons. No funds are currently set aside in the Nuclear Waste Fund for this. Furthermore, Lindskog says that RD&D 2010 should provide material for Plan 2011 and it is in this plan that the work of reforming the system will commence. He therefore urges patience until this time.

Ingvar Persson fills in:

"The Government writes in its decision on RD&D 2004 that SKB should study the quickest dismantling option. What was discussed was Kävlinge Municipality's appeal of the environmental court's decision that Barsebäck's shutdown operation could continue until 2012. Kävlinge Municipality wanted to start dismantling earlier.

Persson also says that SKI then expressed the view that dismantling of the nuclear reactors should not be commenced until suitable final repository facilities were in place with permits for the decommissioning waste in question.

"In order to make it possible for the best available technology to be used for final disposal of the decommissioning waste, the Inspectorate thought that it should be conditioned and packaged with a view to the environment that will exist in the final repository," says Ingvar Persson and points out that SKI also observed that there are no interim storage facilities or final repositories available at present, which they brought to the attention of the environmental court, which had to rule on Kävlinge Municipality's appeal.

Persson also notes that the state in, for example, the UK, the USA and France has assumed responsibility for building nuclear waste repositories. This is not the case in Sweden, however, where the Swedish state has given the nuclear power industry full responsibility for operating, decommissioning and dismantling the nuclear power plants and building a final repository. But the industry must at the same time have permission under the Environmental Code to do this. This enables the environmental court to stipulate certain conditions, which was done in the case of Barsebäck. The court gave permission for shutdown operation up

to 2012 and said that studies were needed regarding the possibilities of a quick dismantling of Barsebäck.

SKB's altered plans for decommissioning from 2015–2020

Clas Otto Wene:

"How did SKI react to the fact that SKB, within the course of three years (between RD&D 2001 and RD&D 2004), changed its plans from having the repository for short-lived waste ready by 2015 to being ready by 2020?"

Staffan Lindskog replies that what the Swedish nuclear power industry has done is to focus on the KBS-3 concept, which has left a shortage of resources for working with other issues. But a postponement of up to about five years from the original plan should be regarded as a normal deviation.

Why don't the regulatory authorities require SKB to study earlier dismantling?

Clas-Otto Wene observes that the Government decision on RD&D 2004 called for a study of the possibility of earlier dismantling. He wonders whether SKI should be more active in this matter.

Staffan Lindskog:

"2010 and 2013 are suitable dates. Research is also being conducted internationally. The most important thing is that the new authority formed by the merger of SKI and SSI finds a good organizational identity for these questions."

Relicense SFR 1?

Eva Simic wonders whether SKI has looked at the possibilities of relicensing SFR-1 to also include decommissioning waste, but according to Ingvar Persson SKB is the licensee and it is therefore up to them to apply. The Inspectorate cannot ask SKB to do this.

Must a final repository for decommissioning waste exist before dismantling is commenced, or can an interim storage facility be utilized?

One of SKI's standpoints is that dismantling should not commence before suitable repositories exist with permits for decommissioning waste from nuclear facilities. According to Ingvar Persson, this means that the Barsebäck reactors can remain standing until suitable final repositories exist or facilities for interim storage have been built.

Kjell Andersson:

"Can SFR-1 be a suitable final repository if SKB submits an application to operate SFR-1 for decommissioning waste and obtains a permit?"

Ingvar Persson replies that if SKB applies for such a permit, the application has to be examined and the Government will then decide on a permit. The new merged authority will in that case stipulate conditions for the activity.

Kjell Andersson:

"SKB notes that there is no interim storage facility for decommissioning waste. But is there space for interim storage of decommissioning waste in the different nuclear power plants' previous interim storage facilities for operational waste? If the industry applies for permission, could such an interim storage option become a reality?

"It may be possible for Barsebäck to begin dismantling today," replies Ingvar Persson. "Then the plant could store certain parts of its decommissioning waste on site, but this doesn't help Kävlinge Municipality, which has other plans for the site. The Barsebäck plant may remain in place for a considerable time before we have final repositories for the decommissioning waste."

Can the dismantling process be speeded up by the legal process?

There are two processes. First there is the RD&D process where SKI submits statements of opinion to the Government, and then there is a decision process under the Environmental Code that

includes environmental impact assessments and consultations. The processes are different in that the first is more technical while the latter is more democratic and socially oriented since it goes via the environmental court.

"Is it possible via the EIA process to study several different time scenarios for dismantling and see what advantages and disadvantages they would entail?" asks Harald Åhagen.

Ingvar Persson replies that the laws are parallel (the Nuclear Activities Act and the Environmental Code). It is the industry, in this case Barsebäck Kraft AB, that applies for permits.

"Now they have applied for a permit for shutdown operation, and the environmental court has to rule on this. Otherwise, Barsebäck has a licence to own nuclear power plants. They have set aside money in the Nuclear Waste Fund and will use it for decommissioning and dismantling. But this can be done at the pace preferred by the industry itself, since the industry bears the responsibility," he says.

Kjell Andersson points out that quick dismantling is an important issue for Kävlinge Municipality, but no dismantling project has yet been initiated.

"So at present there is nothing to consult about and no way for the municipality to exercise any influence," he says.

That's correct, says Persson.

"The municipality has certain opportunities to exercise influence via the Planning and Building Act, but they are not easy to exploit. A new plan to build housing requires purchasing the land, and that is not likely to be cheap," he says.

Andersson also points toward the "strategic environmental assessment" that applies to plans and programmes, but also to national authorities and municipalities. Is it possible for Kävlinge to start a strategic environmental assessment for decommissioning of the Barsebäck plants now?

"Kävlinge has a planning monopoly and the instruments provided by the Planning and Building Act, but there are financial obstacles to exploiting the opportunities provided there. There must be a dialogue between the municipality and the industry concerning a suitable procedure," says Ingvar Persson.

Björn Hedberg points out that the regulatory authorities clearly cannot require the industry to dismantle sooner than the industry wants. But in the RD&D programmes the regulatory authorities

can make recommendations to the Government, which can make a decision on the orientation of SKB's work.

Ingvar Persson:

"The state wanted to make sure from the start that the nuclear power industry would prepare a research and development programme for the comprehensive R&D activities needed for them to fulfil their obligations to decommission and dispose of the spent nuclear fuel and nuclear waste generated by the activity in a safe manner. The programme has come to be called the RD&D programme and has to be submitted every three years to SKI, which reviews and evaluates the programme together with SSI. It is then submitted to the Government. In conjunction with its examination of the programme, the Government can stipulate conditions for the continued research and development activities."

Economically better to dismantle early or late?

Eva Simic:

"Are there advantages from an economic perspective to dismantling Barsebäck early or late? Are there any financial obstacles to dismantling earlier than planned?"

Staffan Lindskog:

There are both advantages and disadvantages to early dismantling. There should be a waiting period of at least five years before dismantling is started to allow the radiation levels to decline. In many countries the judgement is made that dismantling should begin immediately in order to take advantage of the knowledge that exists. In the plan report, immediate dismantling entails dismantling as soon as the reactors have been shut down.

4 SKB's programme for decommissioning

Jan Carlsson, SKB

The Swedish Nuclear Fuel and Waste Management Co, SKB, is owned by the Swedish nuclear power companies and has been tasked to manage and dispose of spent nuclear fuel and radioactive waste from the Swedish nuclear power plants. In addition, SKB manages similar waste from industry, research and medical care which goes to the SFR facility, i.e. the final repository for low- and intermediate-level short-lived waste.

Shared responsibility for decommissioning

When nuclear power plants are to be decommissioned, responsibility is shared between the nuclear power industry and SKB. But the industry decides itself when to decommission. There is also a division of responsibility between those who have a licence to operate the nuclear power plants, i.e. the industry, and SKB when it comes to decommissioning. SKB has been producing preliminary decommissioning studies since the 1980s on which the calculation of the decommissioning costs is based. SKB is also planning how decommissioning will be carried out, what technology will be used and how the waste will be packaged. They are also compiling background material as a basis for planning the final repositories. SKB and the industry are also studying decommissioning in a joint decommissioning group in which representatives from all the nuclear power plants participate.

"The industry has responsibility for the final decommissioning studies and goes into how decommissioning will be executed in detail. Then the power companies carry out the actual decommis-

sioning. They also apply for permits for decommissioning and carry out consultations and EIA," says Carlsson.

In conjunction with the actual dismantling work it is SKB that manages the radioactive waste that arises, while the industry is responsible for disposal of the non-radioactive material.

SKB's programme for decommissioning

At present, SKB is working on how to manage the low- and intermediate-level waste (LILW) in the LILW programme, which includes operational and decommissioning waste.

Other important activities include extension of the final repository in Forsmark to receive the short-lived low- and intermediate-level decommissioning waste.

"For the past 20 years we have also been carrying out renewed studies of decommissioning of nuclear power plants and own facilities. Furthermore we are planning for the management and disposal of the long-lived waste," says Carlsson.

SKB's facilities for disposal of low- and intermediate-level waste

SKB has a final repository for short-lived operational waste in Forsmark that was put into operation in 1988. The company plans to extend this repository in two stages. The first stage is planned to be finished by 2020, and that is where the short-lived decommissioning waste from Barsebäck and Studsvik's R2 reactor and Ågesta will be disposed of. The second stage of the extension of the repository depends on how long other nuclear power plants are in operation. The plans have been changed as a result of different political decisions.

"At first they were not supposed to be kept in operation beyond 2010, then that was changed to 40 years of operation, and now it's as long as the plants are safe, and we expect the nuclear power plants to last for 50–60 years," says Carlsson.

SKB is planning to interim-store the long-lived waste from power increases and modernizations of the nuclear power plants. This long-lived waste includes reactor internals, which they want to

store in both wet and dry storage facilities. The CLAB facility can be used in the latter case.

The plans for final disposal of the long-lived waste lie far in the future, in 2045. The reason for this late date is that although the waste arises now, the volumes are small and SKB does not consider it optimal to build a final repository now to which small quantities of waste are gradually added. These small quantities can just as well be stored in an interim storage facility.

"But we do think that the large volumes of short-lived decommissioning waste should go directly to final disposal," says Carlsson.

Waste containers and location in SFR

The containers that are used and will be used for operational and decommissioning waste are of different sizes and will be placed in different locations in the SFR facility. Jan Carlsson says that SKB plans to pack most of the decommissioning waste in large freight containers, since they are easy to pack in.

For the long-lived waste that will be stored dry, SKB plans to use the same geometry for the containers as a concrete tank (1.3 x 2.3 x 3.3 m), but they will instead be made of steel. Whereas the operational waste consists of filter resins, the long-lived waste consists of iron scrap. Unlike many other countries, Sweden is also able to manage large components. Carlsson shows an example from Forsmark of a reactor vessel head from a pressurized water reactor in Ringhals and says that SKB can also manage other large components without containers.

Timetable for extension of SFR, stage 1

SKB has presented its plans for extension of the SFR facility in RD&D 2007.

"The goal is that it should be finished by 2020. To manage this we have started the project with feasibility studies and planning. We are in control of the time this takes until we submit a permit application for extension to the regulatory authorities, which we plan to do in 2013. By then we will have completed an EIA, consultations, site investigations, designed the facility and performed

safety assessments on the extension," says Carlsson. He points out that SKB is not in control of later parts of the process, by which he means the regulatory review of the application.

"Hopefully after two years we will get a permit to build and then we will get started," says Carlsson.

But before operation of the finished facility can get under way, one more regulatory review remains to be done before an operating licence can be obtained. SKB assumes that this will take a year, after which, in 2020, the newly built repository will be able to receive waste. The EIA process under the Environmental Code, the consultation procedure etc. take place in parallel with this process.

Planning premises

SKB's planning assumes that dismantling of the Barsebäck plant will begin when the extension of the repository is finished in the near future, around 2020. SKB also assumes that the operating time for other nuclear power plants is at least 50 years. The objective is to be able to manage the decommissioning waste as soon as possible after the nuclear power plants have been shut down and the fuel has been removed. This period should be as short as the licensees, i.e. the industry, wish. This also entails early dismantling.

"Early dismantling is what we want for Barsebäck as well. As early as we can manage," says Carlsson, pointing out that a decision on when to close Barsebäck was made at the end of 2004. That was when SKB began to plan for dismantling and to be ready with a repository for the waste in 2020 at the earliest.

"If Barsebäck had been operated longer we could have deferred the time for dismantling and disposal, since other power plants are in operation 20 years longer."

SKB also assumes in its decommissioning studies that the area and buildings will be used for other industrial activities. When all radioactive material is gone, the plant will be released for unrestricted use in accordance with SSI's regulations and the facilities will be exempted from the requirements of the Nuclear Activities Act and become conventional industrial facilities.

Decommissioning studies

SKB has been carrying out decommissioning studies for a long time. A detailed reference study of boiling water reactors has been completed. Another about boiling water reactors is about to begin. A study of the whole Barsebäck site is currently under way. Studies of other plants, both boiling and pressurized water reactors, will be completed in 2010. Based on these, SKB will know what waste exists and how it should be packaged, what the volumes are and how much radioactivity the decommissioning waste contains. Data will be compiled as a basis for designing the final repository.

Is there room for Barsebäck's decommissioning waste in the existing SFR?

When the Barsebäck NPP is dismantled, a repository is needed for the radioactive waste. An alternative could be to use the existing SFR repository in Forsmark, which is a repository for low- and intermediate-level short-lived waste. According to Carlsson, there is enough volume for Barsebäck's decommissioning waste in the existing SFR, but the space is intended for operational waste, not this form of waste. There is a small volume in SFR for operational waste still present in Barsebäck because the plant was shut down prematurely, but this space is not sufficient for the plant's decommissioning waste. Other space is intended for operational waste from other power plants.

"So SFR cannot be used for Barsebäck's decommissioning waste," says Carlsson and points out the importance of having a long-term strategy and not looking for short-term solutions that risk creating other problems further down the line.

Is there room for Barsebäck's decommissioning waste in the existing BFA?

The Oskarshamn nuclear power plant has an interim storage facility for long-lived operational waste called BFA. SKB has the right to use a part of this space. That part will be used for the long-lived intermediate-level operational waste that arises in conjunction with modernizations of power plants, such as reactor internals and core

components. The rest of the space is OKG's and is used for buffer storage of the nuclear power plant's operational waste.

SKB does not think there should be any interim storage of decommissioning waste, since it would entail an unnecessary management stage. The waste should be sent directly to final disposal.

5 Preparations for the dismantling of the Barsebäck plant

Leif Öst, Barsebäcks Kraft AB

Barsebäck Kraft is a company in the Vattenfall Group, wholly owned by Ringhals which in turn is 70% owned by Vattenfall and 30% by E.ON. Responsibility is divided between the companies by means of an agreement. E.ON. still owns the Barsebäck plant while Barsebäck Kraft AB is responsible under contract to E.ON. for shutdown operation and planning for decommissioning and dismantling. E.ON. has overall responsibility for the decommissioning of Barsebäck, while Vattenfall is responsible for the future decommissioning of Ringhals.

Swedish model for dismantling

Leif Öst contends that we in Sweden have a joint decommissioning policy embodied in the RD&D reports. They provide a model for how decommissioning and dismantling should be carried out which is based on planning decommissioning well in advance.

When a nuclear power plant is closed, it switches over from normal operation to defuelling operation, which means that the fuel is still at the station. When the fuel has been taken out of the reactor and transported to the interim storage facility at CLAB, shutdown operation begins. This also marks the start of the planning of future dismantling including decontamination, project planning etc.

"Our experience shows that defuelling operation takes 2–3 years, while shutdown operation and preparations for dismantling take up to 2 years. We believe that dismantling will take 5–6 years, followed by regulatory review and free release of the plant. This

will be followed by site remediation based on the intentions of the owners with respect to buildings and land."

Prerequisites for dismantling are that the necessary repositories, logistics for dismantling, transportation and disposal and all the necessary permits are available, says Öst.

The Swedish model is based on early dismantling, and this model was applied to Barsebäck, but reality turned out to be different, says Öst.

"We took Barsebäck 1 out of service 1 in 1999 and the other reactor in 2005. As Site Manager for the company, I didn't know 35 hours before Barsebäck 2 was shut down whether I was supposed to continue operation or shut everything down. Is this a planned shutdown?" he wonders. "Barsebäck had not conducted an EIA or met other conditions that should be fulfilled for shutdown operation."

Barsebäck currently has both reactors in shutdown operation and is planning for dismantling. Different alternatives have been considered in the environmental impact assessment carried out by the plant and in the environmental permits, including an alternative with interim storage of the waste.

"Based on the Environmental Code's general rules of consideration and the precautionary principle etc., we arrived at the conclusion that dismantling with immediate final disposal is the best alternative. Other alternatives entail higher radiation doses and greater waste volumes, but above all higher costs. Barsebäck is currently planning to start dismantling in 2020, which is when the repository for decommissioning waste (SFR 3) will be ready," says Öst.

The need to protect the environment from radioactivity changes radically with time, and Öst is careful to point out that it is important that the regulatory authorities take this into account in their regulations. When the nuclear fuel is gone from the plant, all nuclear risks are also gone. All that remains is the radiological risks that have to be taken into account for occupational health reasons. The requirements and regulations that are imposed have an influence on e.g. waste volumes and the dismantling method.

The regulatory authorities stipulate requirements on reporting. Barsebäck has an environmental permit that is valid until 2012. A new EIS and a permit are required before dismantling. SSI's and SKI's regulations on a decommissioning plan and a safety plan including an EIS must be complied with. An updated safety analy-

sis report is required prior to shutdown operation, and another prior to dismantling.

Shutdown operation, which will last for about 10 years, entails for Barsebäck the objective of achieving the least possible environmental load, and the least impact on resources and the environment.

"We are working to achieve simple, safe and optimal shutdown operation. This means, for example, that we are trying to minimize energy consumption. The systems will be shut down and drained, we will reduce electricity consumption, water consumption etc. We will make certain alterations since the ventilation doesn't have to be as high as during operation and thereby reduce energy consumption," says Öst.

Barsebäck is working on a new safety analysis report and a new business management system. The plant is planning to conduct training of maintenance personnel for the other power plants. The workforce will be cut back, but in the long term about 160 persons will work at Barsebäck.

Barsebäck is working with decommissioning planning and experience exchange in several international networks and organizations, including the EU, the IAEA, the OECD-NEA, the EPRI and others where safety standards are being prepared, for example. Experience is being gathered which can later be applied to our own activities.

Safer, faster and more cost-effective dismantling

Barsebäck's ambition for the dismantling phase is to carry out the work more safely, faster and more cost-effectively than in other decommissioning projects completed thus far in the world. This requires that the risks be reduced or eliminated. One way to do this is by system decontamination. Plant components are planned to be disposed of in large pieces, and the work has to be well prepared, the safety analysis report has to be in place, etc.

"We are also creating the prerequisites for smooth logistics in order to speed up the dismantling. We do this by ensuring that the process for the different waste types is completely ready in theory before it is put into practice. The day we start dismantling, every valve and pump should in principle have a label saying how it should be managed and where it should be disposed of," says Öst.

"In order to make dismantling cost-effective, the focus must be on the timetable and meeting the requirements on safety and speed."

How will the plant be dismantled?

The big components will be removed from the plant first, since they contain the most radioactivity. It may be possible to remove the reactor vessel in one piece, since it was once installed that way, followed by other system parts and buildings that are contaminated. Then the plant can be released for unrestricted use, after which all that is left is demolition of the buildings.

Today the personnel are working to determine the radioactive inventory at the power plant. In one project the amount of radioactivity in the concrete in the biological shield, and in walls, floors, etc. is being estimated. Drill samples have been taken, measured and surveyed. The personnel have gone through the facility to see where they have had floods etc. during the operating period in order to see how much radioactivity there is.

A model has been created for the dismantling process and the method is described in control documents. The actual dismantling is planned to take five years. This is faster than the dismantling of similar plants, but Öst says that the work can be speeded up by thorough preparations.

"What we do in Barsebäck will yield valuable experience for the Swedish nuclear power industry."

6 Questions and discussion based on Carlsson's and Öst's presentations

Clas Otto Wene:

"What happened between 2001 and 2004 when SFR was suddenly postponed by five years in RD&D 2004?"

Claes Thegerström from SKB explains that when the company wrote RD&D Programme 2001 there were still plans to phase out nuclear power by 2010 and decommission the plants by 2015. "But between 2001 and 2004, political decisions changed the framework conditions for when nuclear power was to be phased out. Now the rule was an operating time of 40 years. This has subsequently been developed to mean 50–60 years of operation in practice," he says, pointing out that between 2001 and 2004 the state decided to close Barsebäck reactor 1, but not reactor 2.

"A basic principle for the nuclear power industry is to start dismantling the nuclear power plants when nearby reactors at a plant have been shut down. When we wrote RD&D 2004, reactor 1 was shut down but no. 2 was still in operation and no decision had been taken to shut down this reactor. Based on the fact that the rule was now an operating time of 40 years, we decided that an extension of SFR for decommissioning waste would be needed some time in the 2020s. After 2004 the decision came to close Barsebäck 2 and SKB took this into account in its 2007 planning. We then had the two Barsebäck reactors out of service and could shorten the time until dismantling. The decision to close came from the politicians, not from the owners of the nuclear power plants. We had to adjust our planning to their decisions."

Clas-Otto Wene concludes from this that SSI, SKI and the Swedish National Council for Nuclear Waste should have requested in their review statements an economic evaluation of the

costs and gains of immediate or deferred dismantling in order to determine the economic outcome of SKB's changed plans.

Interim storage, the precautionary principle or optimization? Greater environmental effects with interim storage?

Barsebäck has studied the alternative of interim storage in the environmental impact statement for the shutdown operation for which the plant received a permit last year. Leif Öst says that the results showed that immediate disposal is best.

"Not much is to be gained by building an interim storage facility, since it takes a long time to get a permit. Interim storage also requires the handling of large quantities of decommissioning waste, which increases the radiation dose and costs resources for society," he says.

But how is this conclusion related to the precautionary principle? Öst says that an interim storage facility has a greater environmental impact due to increased radiation doses. The decommissioning waste has to be handled several times if it is to be interim-stored, the handling is greater in scope and resource consumption is greater in the form of energy use. If these costs are compared with what is gained, immediate disposal is best. The increased costs come from the fact that an interim storage facility has to be built for the decommissioning waste. Comparisons with Germany show that such a facility would cost at least SEK 1 billion.

Kjell Andersson points out that this is primarily a question of radiation protection and has no relation to the precautionary principle, and gets the reply that Barsebäck is in agreement with the regulatory authorities on the radiation protection principles.

How large volumes will be stored after a dismantling of Barsebäck?

The actual volumes that will be stored after a dismantling cannot be determined, according to Harald Åhagen. There are different estimates from SKI and SKB. The volume, which can vary between about 10,000 and 20,000 cubic metres, is of great importance, for example for a relicensing of SFR-1, he says.

Jan Carlsson, speaking on behalf of SKB, says that the volume of the waste is dependent on how it is packed. The actual volumes do not differ so much.

"We think it is best to store as large components as possible, which means that the volumes are large because certain items are hollow. If they are segmented the volumes are reduced, but the personnel receive a higher radiation dose."

Can SFR be used for decommissioning waste from Barsebäck?

Harald Åhagen says that the big differences in reported volumes must be of importance in terms of whether SFR can be used or not. Jan Carlsson points out that SFR is built to be used for operational waste. After an extension, decommissioning waste will also be stored there.

"Barsebäck still has some volume for operational waste that will be stored in SFR-1. But Barsebäck's share in SFR is small. The rest of the volume will be used by other nuclear power plant owners for operational waste," he says.

Kjell Andersson doubts if it can be regarded as optimization of the space if decommissioning waste is deposited in SFR, but Jan Carlsson doesn't agree.

Saida Lâarouchi Engström points out that the space for operational waste to be deposited in SFR is apportioned among the owners.

"Long-term planning is called for in all contexts, and it is said to be important that this is complied with. SKB does not want to depart from its long-term planning for safety reasons," she says.

But, wonders Björn Hedberg, could a clearer account be given of each power plant owner's need of space in SFR-1 compared with the total volume?

"The discussion is about whether the industry thinks that an optimization of the existing system should be done. The question is what it would entail if dismantling of Barsebäck were to start sooner. SKB and Kävlinge Municipality have during the seminar described their respective standpoints as to what is optimal for them."

"We are trying to clarify what different alternatives would entail," adds Kjell Andersson. "Purely physically, it would be pos-

sible to use the existing SFR for decommissioning waste. You would need three years to apply for a permit to use SFR this way and the regulatory authorities would need three years to issue a permit. But the existing agreements between the power companies would have to be changed. Furthermore, there is no repository for the rest of the operational waste."

Jan Carlsson replies that it would be physically and technically possible to utilize the existing SFR-1. There is enough volume. But SFR consists of different repository parts, and it would be most efficient to pack most of the decommissioning waste in large freight containers. The space for such containers is limited.

"If we assume that we have 30,000 m^3 of space, only a few hundred cubic metres is accessible to large containers. If decommissioning waste is to be placed in SFR, this means that material must be handled and packaged differently and packed in containers that fit into other parts of the facility. In this case, other companies must give of their space."

Leif Öst points out that if decommissioning waste is to be placed in SFR, the whole facility will be utilized. If the slightest disturbance occurs in the extension of the repository, there may not be enough space for the nuclear power plants' operational waste. If there is not enough storage space for the operational waste, the power plants cannot be operated.

Jan Carlsson says that the whole logistics for decommissioning and decommissioning waste, as well as the basis for cost calculations, is upset.

"This would be the effect of using a storage facility that is not designed for decommissioning waste. I don't think the power companies are willing to take that risk."

"Checkpoint 2012"

SKB has a new checkpoint in 2012 when the environmental court's permit for shutdown operation expires. This, asserts Harald Åhagen, was put in by the environmental court because it required supplementary information to issue a permit for shutdown operation. Does SKB intend to provide answers in at this time to the question of whether the dismantling of Barsebäck will take place earlier or later?

But Leif Öst claims that the question had to do with the fact that the environmental court did not consider there was enough information to determine the most suitable time for dismantling.

"To determine this, the environmental court wanted to wait for RD&D 2007, and if earlier dismantling was possible the court would give us the time that was needed for the licensing process. That is why 2012 was set as the date for getting back about this."

SKI critical of SKB

Stig Wingefors says that SKI has not observed the process in silence. We have warned of the problem that the timetable was postponed in connection with RD&D 2004 and even earlier in conjunction with the plan report. We stated our opinion in the matter to get better transparency and get arguments on the table, such as the volume aspects, the logistical aspects, the radiation protection aspects, the safety aspects and the economic aspects. We expected such an account in RD&D 2007. We wrote in our review statement on RD&D 2004:

> SKI would like to point out that the question of a relicensing of SFR to receive short-lived decommissioning waste should be investigated during the next few years. This could enable the decommissioning waste from the reactors to be disposed of directly in SFR.

SKI also wrote that: "In SKI's view, in the light of the line of reasoning presented above, work on decommissioning issues needs to be intensified during the next few years with the aim of presenting a clearer plan in RD&D Programme 2007."

And further: "In SKI's opinion, SKB and the reactor owners should already now start planning the work of reviewing the possibilities of rescheduling to an earlier date some of the processes leading to a more rapid dismantling and disposal of the waste."

"What we wrote is precisely what we are discussing here," says Wingefors. "SKB has not lived up to our expectations. SKB refers to the studies that were made by Barsebäck in conjunction with the EIA, but we will have to consider whether these are sufficient."

SKB about the extension of SFR and the LILW programme

SKB is now focusing on the waste management programme for low- and intermediate-level waste (the LILW programme), which will be presented in RD&D 2010. The company has intensified the work and been given more resources for it. In the matter of using the existing SFR, Jan Carlsson thinks that everyone is agreed that both operational and decommissioning waste will ultimately be deposited there. But it must first be shown in a safety assessment that this is possible.

"In preparation for the extension we are working on a safety assessment and it must be completed, even if the intention is to use existing space in SFR for decommissioning waste. The assessment must show that the two waste categories can co-exist in the facility. This safety assessment will be presented in 2013 in SKB's application for a permit to extend the facility. We may be able to get approval by 2015. But it mustn't end with our having to have a new site selection process for operational waste, that would be unfortunate," he says.

Claes Thegerström would like to emphasize the fact that SKB has strengthened its resources considerably, that they have expanded the LILW programme and recruited personnel. The company has a project for extension of SFR.

"It is not a foregone conclusion that an extension of SFR for decommissioning waste can be managed without problems. It is possible that it will be possible in the coming period to make reallocations of the space, but we can see that there might be reasons against this from a safety point of view. It must be shown that there is enough space for operational waste."

Uncertainties in the cost calculations for decommissioning

Expenditures for decommissioning will lay claim to a large portion of the nuclear waste fees. The risks appear to be known, but where are the greatest uncertainties in the cost calculations? asks Eva Simic.

Jan Carlsson explains that the calculations are done based on the assumption that we dismantle today. Then a standard uncertainty

can be used that is based on experience of decommissioning at other places or of similar activities.
"We add allowances depending on what part of the facility the calculations are performed on. There are uncertainties in what will happen in the future, such as estimates that are made in the planning work for future costs for the future waste work. We have an analysis group that looks at different risks. The cost calculations for decommissioning are done deterministically, while those for the system are based on a probabilistic calculation that enables us to see how the uncertainties affect the entire system, not just decommissioning. If we figure that decommissioning costs SEK 16 billion, there are uncertainty and risk allowances of SEK 12 billion. This applies to the whole system."

7 Radiation protection aspects and regulatory requirements

Henrik Efraimsson, SSI

The purpose of decommissioning from a radiation safety viewpoint is to reduce the risk of unintentional exposure and spread of radionuclides. Unauthorized persons can enter the facility and be exposed, there is a risk that someone could remove material and put it to illicit use, and the facility could fall into disrepair so that radioactivity leaks out. The material therefore needs to be removed and treated.

Radiation protection aspects

One of the most important radiation safety aspects of decommissioning is to minimize the doses to the personnel. Decommissioning must therefore be carefully planned, but there are nevertheless risks for unplanned doses.

"Decommissioning involves large quantities of waste, of which only a small fraction is radioactive, but should nevertheless be minimized. It is also necessary to try to avoid producing more radioactive material during the decommissioning process," says Efraimsson.

The material must be handled and transported safely, and it must be ensured that the right waste ends up in the right place. Space for radioactive waste may not be used for non-radioactive material. Clean (uncontaminated) material can and should be released from regulatory control and reused. The risk of radioactive releases make environmental monitoring important in order to see what consequences the releases have on the environment. Decommissioning also changes the risk picture compared with when the

facility is in operation, and it may be necessary to take this into consideration when it comes to emergency preparedness and physical protection.

SSI's requirements from a radiation safety viewpoint

The regulatory authorities impose certain requirements on decommissioning. Among other things, records must be kept during the nuclear power plant's lifetime so that the history of the plant will be known when the time comes to decommission the plant. Different alternative decommissioning scenarios must be analyzed. Decommissioning plans must be made progressively more detailed the closer the time for dismantling comes. SKI's regulations contain requirements on special safety assessments for operation in the final phase from when a decision has been taken on closure and until the plant has actually been closed. The reason is that the final phase is a particularly sensitive period from a safety viewpoint. A safety analysis report must also be produced for decommissioning.

When should a closed plant be dismantled with a view towards radiation protection?

Important factors for determining the optimal time for dismantling are the type and status of the facility. What type of plant are we dealing with and how are the radionuclides distributed? How has the plant performed and what problems have to be dealt with? Different events may have given rise to situations that require more or less dismantling work.

"It's important to remember what makes the issue special, namely how the radioactive substances have been held in check during operation," says Efraimsson.

How does radioactive decay affect the choice of when to dismantle?

When is it more or less appropriate to dismantle? Certain nuclides decay very rapidly, which has a great bearing on how much radioactivity the personnel are exposed to. Cobalt 60, for example, has a

half-life of five years. But the dose received by the personnel is also dependent on the dismantling method. Henrik Efraimsson takes the example that robot technology can be used in the event of an immediate dismantling when the dose is high, but that the choice may be to do the work manually if dismantling takes place after 20 years. This would mean that the personnel would nevertheless receive a larger dose in the case of deferred dismantling.

Another aspect is, for example, new requirements on electrical systems which mean that parts have to be replaced or that a whole new system has to be installed. This raises the dose to the personnel even in the event of deferred dismantling.

System decontamination can be done for the nuclear power reactors, and Efraimsson says that this is what has been done for Barsebäck 2. He considers this to be an effective way to reduce the dose rates in the most contaminated parts of the systems.

"Immediate system decontamination can save 20 years of waiting. Radioactive decay then loses its importance. But if you have a plant with long-lived nuclides there is almost no variation in the time at all when it comes to decay," he says.

How is the time of dismantling affected by the radioactive waste?

The volume of the waste is important during dismantling, and it is desirable to handle as small volumes as possible. How decay affects the quantity of waste is only marginally important, since it will only be possible to handle a small portion of the radioactive material as non-radioactive. The bulk of the waste remains radioactive. If dismantling is deferred the systems need to be rebuilt, which gives rise to more waste.

In order for the waste to be free released, i.e. judged to be so clean that it can be reused, its radioactivity must be measured. The short-lived nuclides are easier to measure than the long-lived ones. If the waste is a mixture of short- and long-lived nuclides, there may be a problem if dismantling is deferred. After some time only the long-lived, hard-to-measure nuclides are left. It may then be difficult to show that the material is so clean that it can be free released, and as a consequence the quantity of waste increases dramatically. This is because large quantities need to be measured to show that the waste is clean.

"An example of this could be the Ågesta reactor, which has had a lot of damaged fuel that has released large quantities of long-lived nuclides. But we don't know yet whether this is a problem or not. This problem has been identified in Germany," says Efraimsson.

Factors such as logistics and costs also affect the radioactive waste.

"When the personnel package the waste during dismantling, they need to know what the final repository looks like. Otherwise there is a risk they will have to repackage it. And if there is no final repository in operation or approved containers for the waste, they take a risk," he says, noting that the best thing is to coordinate planning of decommissioning and planning of future repositories.

What technology development can be expected and what importance does it have?

The technology for dismantling exists today. Henrik Efraimsson considers it speculative to assert that it is better to wait to dismantle because new technology will be developed in the future.

How important are knowledge and resources?

When the time comes to dismantle the plant it is valuable to have people who know what has happened during operation, especially if things are found during dismantling that cannot be explained by reference to the operating records.

If dismantling is deferred for many years, the personnel will leave the company in the meantime. This may make dismantling more difficult, especially in the case of unusual plants such as research plants with a complicated history. If there are similar plants in the country, it might be possible to get the information there, says Efraimsson. But there is no guarantee.

It may therefore be worse from a radiation protection point of view to postpone dismantling, and there is a risk that the wrong decision will be taken due to ignorance of the plant's history.

Other factors that have a bearing on the choice of the time of dismantling

- Access to financing of manpower and equipment, as well as availability of storage facilities.
- Proper documentation: have records been kept carefully so that the right decisions can be made during dismantling?
- What does it cost to maintain a plant awaiting dismantling and what do dismantling, waste management and storage cost?
- Regulatory requirements also influence how dismantling is done. Certain rules may have to be established before dismantling can start. SSI has seen a trend in the history of radiation protection: the regulatory requirements increase with time.
- How the site will be used after dismantling, as well as what labour market policy is applied in the region.
- What goodwill the industry wishes to achieve. The industry can show that the waste is being dealt with and demonstrate their ethical commitment by not passing on dismantling to future generations.
- Dismantling provides opportunities for developing skills, methods and competitiveness. It will be possible to verify a variety of assumptions regarding how dismantling should be done, what it will cost, etc.
- Systemic inertia. Decision processes take time, as do consultations. Plans must be reviewed and revised. There is also a bureaucracy for organizing and obtaining resources among regulatory authorities and industry.

SSI's standpoints

In SSI's view there are no good reasons to postpone dismantling.

"We also believe it should be technically possible to finish the work on the site within 10–15 years. Then all radioactive material must have been removed from the site. Stores for waste are still needed," says Efraimsson.

Nor does the Inspectorate find it acceptable to shift the responsibility to future generations if decommissioning can be done today.

SSI has acted according to its policy in the environmental licensings of decommissioning projects that have taken place in recent years. SSI has questioned why the industry cannot dispose of the waste in SFR or interim-store it in BFA in Oskarshamn. SSI has requested that studies be initiated, which has also been heeded by the environmental court.

"We have also studied the latest RD&D programme and still think there are questions there that have not been sufficiently elucidated."

Efraimsson says that SKB wants to take technical, safety and economic reasons into account in determining the best time for dismantling, but that they have also said it is possible to dismantle today.

"We recommended that the environmental court not accept a delay, and the court agreed."

SSI has also recommended immediate dismantling for the Studsvik project. Studsvik plans to be finished with its decommissioning by 2016. This is a long time, Efraimsson believes, but decommissioning is being carried out even though there is no final repository, and space at Studsvik is being used to store the waste.

"Environmental licensing of shutdown operation is currently under way for Ågesta. There SSI has chosen to encourage the industry to look at alternative possibilities for decommissioning. But the same situation has arisen there as in the case of Barsebäck. The industry has a plan and is sticking to it. They find it difficult to explore the consequences of dismantling earlier. We are trying to get the industry to present its arguments. Then it's another thing to pass judgement on the plans," says Efraimsson.

When it comes to the optimal time for dismantling, he thinks there seems to be complete agreement that this is as soon as possible. But what does "as soon as possible" mean, and is there really a consensus on this relatively new concept? Efraimsson emphasizes the importance of strong resolve in this matter, since the system has high inertia and things take time.

"Let us learn from the case of Ågesta, which was closed in 1974. They are now waiting to start dismantling until 2020, even though the quantities of waste are very modest," he concludes.

8 Kävlinge Municipality on the process of closing and dismantling the Barsebäck plant

Pia Almström, chairman of the municipal executive board in Kävlinge Municipality and chairman of the Cooperation Organization of the Nuclear Power Municipalities (KSO)

According to Pia Almström, the Swedish National Council for Nuclear Waste's seminar on this day is the first time the state has invited Kävlinge Municipality to a forum on nuclear power issues. In conjunction with the political decision to close the Barsebäck nuclear power plant, the state chose to ignore the municipality instead of engaging in a dialogue, and the municipal representatives and inhabitants found out about the closure from the press. She finds it difficult to comprehend that the state does not appreciate the need for a dialogue with all concerned parties before making a decision, although she does understand the political game leading up to such a decision.

Pia Almström says that Sweden's municipalities are following the events surrounding the decision carefully, since it may reflect how the state intends to act when faced with other important decisions that concern the nation.

"The lesson we can learn from this is that all municipalities that are obliged or privileged to host facilities of national interest must always secure their rights by special agreements before the enterprise starts," she says, noting that such agreements must also cover the decommissioning phase.

She advises other municipalities who open their doors to different types of nuclear waste management never to trust laws, regula-

tions or administrative decisions if they wish to secure their rights and the interests of their citizens. A political decision can always be abrogated by subsequent decisions.

Size of the rescue services

Kävlinge is the only municipality that has expanded its fire brigade to meet increased safety requirements. The Barsebäck plant is a co-financier. But no one figured on the downsizing costs for the over-sized fire brigade once the plant had been closed.

"So far the state has not been willing to reimburse us for the extra cost of phasing out the rescue services. The municipality has been made to share the burden of the costs of the closure even though the municipality had no say in the decision to close."

Pia Almström says that the same goes for the labour market consequences of the closure. The state was quick to come up with the Trollhättan and Uddevalla packages to alleviate the effects of other corporate closures, but such resources have been conspicuous by their absence in the case of Barsebäck. Even though exports of Danish coal power have increased as a consequence of the closure of Barsebäck, there has been no increase in the Danish demand for laid-off personnel from Barsebäck.

Decommissioning of the Barsebäck plant

Kävlinge Municipality finds that the span of time covered by the decommissioning plan agreed on by the state and E.ON of 20 years is absurdly long. Especially since plant representatives claim that even now there is no hazardous material left in the plants. The municipality shares SSI's opinion that the radiation risk is at a low level and that there are no safety-related problems associated with early dismantling.

"This means that the dismantling issue is no longer about safety but about money," says Almström and claims that the long-term premises for a sustainable decommissioning have been compromised. For reasons relating to state finances, the state does not want to start eating away at the Nuclear Waste Fund too soon.

Kävlinge Municipality has declared that the land that has been approved for the nuclear power plant must be completely remedi-

ated and that the building permit was only for nuclear power production. The land must be remediated to a greenfield state and the municipality does not want an empty power plant shell to remain, which would spoil the visual and physical environment at Öresund. Instead they want to develop a seaside housing estate with marina and harbour in cooperation with the landowner.

The dismantling process

Almström says that an in-depth analysis is needed of how dismantling will be carried out in practical terms, and this must be done in consultation with the host municipality. The factors that affect the municipal inhabitants most during the dismantling process are radiation safety, environmental sustainability, and the physical dismantling process. The latter is important for the inhabitants since it will take a long time and affect the accessibility of roads and areas within the municipality.

The free released waste cannot be landfilled within the boundaries of the municipality, and the municipality therefore wants the plant owner to settle on a joint plan with the regional waste management company Sysav. In a regional perspective, the landfill material can serve as a resource if this is planned properly.

Since the radiation risk in the nuclear power plant declines, Almström wants improved public access to the beach areas on the 20 kilometre long coastline around the Barsebäck plant. It is currently off limits due to the fact that it is classified as a protected area, and she wants the authorities to open the area.

Municipality without compensation

In other countries in western Europe, host municipalities are generously recompensed for having hosted nuclear power production. The municipalities get a share of the production revenues, or, as in Germany, a share of the corporate tax paid by the company. The German host municipalities have also received decommissioning support. In this way the municipality has been able to compensate the citizens for the negative effects of being associated with a nuclear power plant, such as lower real estate prices near the plant. No such compensation is paid in Sweden.

Almström does not believe there has been any net positive effect for the municipality, not even in terms of jobs, since many employees have not lived in the municipality. But when the plant was shut down, small and medium-sized enterprises, contractors and consultants lost an important customer.

"The question is whether any municipality will in the future consent to hosting a similar facility. Even though we have been involved in and supported the enterprise, we have had to pay a high price."

She says the rest of the world has an interest in following what happens in Sweden, for example the GMF (Group of European Municipalities with Nuclear Facilities), the European Commission, the European Parliament and the nuclear power industry's European networks. The decision to close Barsebäck was received by GMF's members with astonishment.

"The politicians don't take responsibility for complete decommissioning once the plant has been closed," she says. "It is technically possible to start dismantling, but the political strength and will demonstrated by the closure coalition prior to the decision fades away when it comes to decommissioning."

9 Questions and discussion based on Efraimsson's and Almström's presentations

What is a probabilistic risk calculation?

A probabilistic risk is associated with possible sequences of events (scenarios) and involves two factors: 1) what might happen and 2) the probability that it will happen. If there are several different future scenarios, they all have different consequences and probabilities. If probability is multiplied by consequence and summed up over all scenarios, you get a probabilistic risk.

Is there room for decommissioning waste in SFR?

SKB wants to have SFR-3 in operation before the company starts dismantling nuclear power plants and says that this is not possible before 2020. SKI also considers it necessary to have a final repository for decommissioning waste in operation at the start of dismantling, which probably means that SFR-3 must be in operation. SSI, on the other hand, believes that immediate dismantling is preferable. Eva Simic wonders whether SSI thinks SFR has to be in operation or not when the dismantling of Barsebäck begins.

Henrik Efraimsson refers to SSI's assessment in the environmental review of Barsebäck. The Inspectorate then believed that it was not clear whether SFR could be used for decommissioning waste. SSI thought that there should be room for the decommissioning waste in the repository. They did not, however, say anything about an interim storage facility.

Eva Simic:

"Do you think the long-term planning SKB wants to have can be managed even if SFR is used for decommissioning waste?"

"Yes," says Efraimsson." "The quantity generated by the dismantling of Barsebäck should fit in SFR without jeopardizing the operation of the other nuclear power plants."

Higher radiation doses from interim storage?

"Did I understand correctly?" asks Harald Åhagen. "Do you mean to say that it doesn't matter that a repository is not available during dismantling? Don't you think the radiation doses would increase due to interim storage rather than sending the decommissioning waste directly to final disposal? Don't you agree with the results of the studies conducted by Barsebäck?"

Henrik Efraimsson says that he has seen Barsebäck's figures, but the power plant has not explained how it arrived at these results.

"I have not seen what the radiation level will be on the packages in question and the volume that is expected to be handled. This background information is needed in order for us to judge the figures. But it shouldn't affect the total dose very much. The extra dose must of course be weighed against the benefit."

Room in SFR

Kjell Andersson wonders about Efraimsson's claim that there is room in SFR:

"How do you know when there is no safety assessment of SFR with decommissioning waste?"

Henrik Efraimsson:

"We consider how much room there is left in the existing SFR and study forecasts for operational waste from other facilities."

"But if you put in decommissioning waste it is another kind of waste – doesn't that matter for the safety assessment?" asks Kjell Andersson.

"There is a safety assessment for operational waste, but none for decommissioning waste. However, we have no indications that there would be any difference. According to SKB, there is no fundamental difference between the properties of decommissioning waste and those of operational waste. They can be mixed. They contain the same nuclides. Individual waste items may of course differ," says Efraimsson.

Decontamination and room in SFR

Björn Hedberg points out that the increased costs for decommissioning are due to the fact that production in the nuclear power plants has been prolonged and that there will therefore be more operational waste to dispose of. Will there still be room for this operational waste?

Henrik Efraimsson says that SSI made the assessment for the environmental review and based on the rough forecasts made by SKB. SSI asked for a more detailed study of what waste categories arise, how they need to be managed and whether they will fit in SFR etc. and arrived at the conclusion that it shouldn't be impossible. It should not be necessary to extend SFR until 2020.

"Barsebäck carries out system decontamination, which removes 98–99% of the radioactivity in the primary system. This represents most of the radioactivity in the entire plant, not counting the radioactivity inside the reactor internals and the waste that has already been disposed of. The waste from system decontamination will be solidified in Barsebäck and transported to SFR, the existing final repository. So within a few years, most of the radioactivity will be taken from Barsebäck to SFR, except for the reactor internals. This is covered by the existing the safety analysis report," says Efraimsson.

Leif Öst points out, however, that the waste volumes are not drastically reduced by system decontamination.

"We reduce the activity content and the dose to the personnel as well as the amount of material left in the power plant, but it isn't so clean that we can release it for unrestricted use."

Rebuilding waste from OKG to SFR

Clas Otto Wene wonders about the rebuilding waste that arose when Oskarshamn 1 was upgraded and renovated – did the rebuilding waste go to SFR?

Henrik Efraimsson says that the reactor internals, which are long-lived and will, according to SKB's plans, be disposed of in 2045 SFR did not go to SFR but are being stored in the bedrock in Oskarshamn. Other scrap is counted as short-lived operational waste.

Wene showed that this scrap is similar to decommissioning waste, which means that a safety assessment should have been done, correct? Yes, that is the case, according to Efraimsson. The waste fit into the existing SFR and encroached on the total available volume in the repository.

Kävlinge Municipality's participation in the process

Harald Åhagen points out that there is an environmental impact statement and an environmental judgement for shutdown operation in Barsebäck and wonders whether Kävlinge Municipality has had an opportunity to participate in consultations and express its viewpoints in the environmental court proceedings? What viewpoints and proposals did the municipality present?

According to Pia Almström, the municipality was not brought into the process until the plant had been closed. She says that the municipality should instead have been included in the process before the decision was made to close the plant. Then they could have offered viewpoints on how long the plant should remain standing and where the waste should be put. She also claims that the Government prevented the municipality from participating in the decision process.

"If Sweden had ratified the Aarhus Convention before the decision had been taken to close Barsebäck, instead of three weeks afterwards, the nuclear power plant could not have been closed without involving the municipality. The Government postponed ratifying this convention because they didn't want the municipality to be involved in the process," she says.

In the environmental court proceedings, the municipality advocated a quick dismantling and used SSI's arguments. However, Pia

Almström does not feel the municipality's standpoints were taken into account.

Kjell Andersson adds that the Aarhus Convention requires that concerned persons should have access to information in matters concerning the environment and have an opportunity to participate in decision-making. The convention also provides for legal recourse if such information has not been provided. He wonders if Almström has proof to back up her claim, or whether this is speculation, that the convention was deliberately ratified two weeks after the decision to close Barsebäck was taken. Pia Almström:

"We are quicker when it comes to other things in the EU. Here Sweden acted very slowly, however. I have no proof, but a strong suspicion."

Municipality and industry do not agree on future land use in Barsebäck

Eva Simic wonders what Pia Almström thinks about the fact that Kävlinge Municipality wants to use the land around the Barsebäck plant for housing, while the industry wants to use the area for industrial activities.

Pia Almström:

"The need for housing is increasing in the densely populated southeastern Skåne region, but there are arguments against building on farmland and destroying natural areas. We are therefore looking at industrial sites. The municipality doesn't have to purchase the land; it can be developed by the landowner. Land prices are high, and it can be a good deal for the landowner."

Per Lindell, Managing Director of Eon Kärnkraft AB which owns the land, replies that the company believes that the site is good for power production due to the presence of transmission lines, harbour and roads. But it is difficult to get a permit for power production if the municipality is not interested.

Pia Almström:

"There is already a detailed development plan and a permit for nuclear activities."

Per Lindell:

"So perhaps all that is needed is a building permit application. But we have tried nuclear power. That didn't turn out so well, so we have to come up with something new."

Preserve knowledge for decommissioning

"According to SSI's policy it is best to dismantle as early as possible. Henrik Efraimsson argues that knowledge of the plant declines with time. With decontamination, decommissioning can be carried out in steps and it is possible to use the knowledge of the plant that is needed early in the process. Is it possible, wonders Kjell Andersson, to postpone dismantling of the parts for which such knowledge is not as important?

Henrik Efraimsson says that this is possible for specific alternatives:

"Ringhals recommends, for example, that the reactor vessels not be dismantled but be allowed to remain standing pending construction of the future final repository for long-lived waste. The dismantling year would then be 2045, which would require some kind of interim storage facility on the site. A decision has not yet been made on what to do with the reactor vessels, whether they should be left intact or segmented to permit easier handling."

Jan Carlsson adds:

"The decommissioning studies that SKB has conducted so far are based on segmented reactor vessels that fit into the waste management system for operational waste. But nowadays SKB believes it is better the larger the components are. Whole reactor vessels can be sent to the final repository. This stands in contrast to what Ringhals says when they discuss the final repository for long-lived waste. The reason why the Ringhals reactors will not be disposed of until 2045 is that they are pressurized water reactors that are not appropriate for disposal in the SFR facility due to the fact that they contain large quantities of long-lived activity. Pressurized water reactors must therefore go to the final repository for long-lived waste. Barsebäck's and the other boiling water reactors' reactor vessels can go to the SFR facility, however."

Kjell Andersson offers an argument that reduces the importance of plant knowledge:

If the reactor vessels in Barsebäck are intended to be segmented, perhaps this could be done early. This would avoid a late need for plant knowledge that may no longer exist. Barsebäck can then wait until SFR 3 is finished.

But according to Jan Carlsson, dismantling of reactor vessels does not require greater knowledge than other work. What is most important is to have persons with knowledge of what has happened in other plants, he says.

Shifting the burden to future generations?

Henrik Efraimsson says that SSI takes a clear stand against shifting the problem of decommissioning of nuclear power plants to future generations. The Inspectorate has stated that this is not acceptable unless there are particular reasons or compelling factors to do so.

Stig Wingefors at SKI wonders what means the regulatory authorities have at their disposal to compel an immediate dismantling so that the problem of decommissioning is not shifted to future generations. Aside from saying that deferred dismantling is not acceptable, we cannot say more than that it is preferable from the viewpoint of society that the nuclear power industry should give a better account of the reasons for its strategy, he says.

But certainly SSI's policy entails that dismantling should be done relatively soon and thereby not take more than 30 years, wonders Björn Hedberg, to which Efraimsson replies that what SSI has said about the generation perspective is that dismantling should be able to take place within 10–15 years.

Claes Thegerström, SKB:

"The industry plans for and is committed to a quick dismantling. We plan to start the dismantling of Barsebäck in 13 years. Then we won't shift responsibility for dismantling to the next generation. The intention is that dismantling should take place soon after the nuclear power reactors have been shut down."

10 Panel discussion and questions from the public

Ingvar Persson (SKI), Staffan Lindskog (SKI), Jan Carlsson (SKB), Leif Öst (Barsebäck Kraft), Pia Almström (Kävlinge Municipality), Henrik Efraimsson (SSI), Björn Hedberg (Swedish National Council for Nuclear Waste)

Björn Hedberg summarizes parts of the day by saying that the discussion has focused on the timetable for the dismantling of the Barsebäck plant, where the municipality wants to have a quicker dismantling than the industry is willing to carry out.

"The question is what we could consider refraining from in order to bring about an earlier dismantling? What parts of the decommissioning programme should be shortened and why? How can this be accomplished? Is it the regulatory authorities who should make the changes or is it SKB or the company's owners?" he wonders.

According to Hedberg, the seminar was not just about the timetable but also about the division of responsibilities. He says there is an agreement between the state and Barsebäck that regulates the question of extra costs resulting from earlier dismantling. It is the state that must pay these costs, i.e. the taxpayers.

Anders Andersson, Energy for Östhammar: Why does Ågesta have to be dismantled?

Henrik Efraimsson, SSI: We want to reduce the risks of radioactive contamination. Someone could be accidentally exposed to radiation from the plant.

Torsten Carlsson, Swedish National Council for Nuclear Waste: Why can't parts of Barsebäck's decommissioning waste be stored on the site? This may entail a type of interim storage until final disposal can take place. Does that create increased costs?

Leif Öst, Barsebäck Kraft: The costs of an interim storage facility in Barsebäck are estimated to be about a billion kronor or more, depending on what standards must be met. An interim storage facility must be located on the plant site, and then no other activity is permitted on the site. But the purpose of an earlier dismantling is to free the land for other purposes.

Bengt Barkman, Environmentalists for Nuclear Power: The Japanese have learned to decommission and dismantle nuclear power plants. Do you have access to documentation from them?

Leif Öst, Barsebäck Kraft: Many countries are good at decommissioning and dismantling nuclear power plants and we are learning from their experience.

Jan Carlson, SKB: The OECD/NEA has a Working Party on Decommissioning and Dismantling (WPDD), where some 30 or so decommissioning projects are under way. The WPDD meets twice a year and makes study visits. It consists of 10–15 countries, including Japan and European countries. Barsebäck is a newcomer, and Studsvik is also included. We study ongoing decommissioning projects and receive reports on them.

Nils-Axel Mörner, MILKAS: I believe that interim storage facilities and the long-lived waste have not been given due attention during the seminar. Shouldn't we define the long-lived waste? Staffan Lindskog says that resources have not been set aside for an interim storage facility, BFA. Kävlinge Municipality has spoken of an interim storage facility, but one possibility is a simple rock cavern similar to the patented DRD (Dry Rock Deposit) concept. Had it been studied, a safe repository would already have existed. How can you build an interim storage facility if you don't have the resources?

Henrik Efraimsson, SSI: The long-lived waste does not fit into a final repository for short-lived waste. Only the parts in the reactor vessel and those that have been irradiated with neutrons during operation need to be managed as long-lived waste. Here we define long-lived waste as having a half-life of 100,000 years.

Staffan Lindskog, SKI: BFA has already been built. It's just a question of licensing it for other waste than that from OKG. No more money is needed for that.

Jan Carlson, SKB: BFA is intended to be an interim storage facility for OKG's operational waste. But SKB has the right to use a part of the store and is therefore able to store waste belonging to the other power companies there. This requires licensing. But we do not think that licensing and modification of the transportation system can be finished earlier than 2011. The volume SKB has access to in BFA is roughly equivalent to the volume of waste obtained from the replacement of internal components in the reactor vessels at the NPPs during operation. At the rate and with the planning we have for long-lived waste, this part of BFA will be filled with reactor internals from the operation of the other power plants.

Nils-Axel Mörner: It is an essential fact that reactor vessels also produce long-lived waste – high-level waste – that must be kept isolated from the biosphere for at least 100,000 years, and that this waste is intended to be "interim-stored" in the virtually unprotected BFA repository, without specification of its "final" disposal.

Henrik Efraimsson, SSI: The reactor vessels are not long-lived waste in the current planning. Only the reactor internals are to be regarded as long-lived waste in the planning.

Synnöve Sundel Bergman, Vattenfall: How is the climate issue being addressed in the planning of a repository? Will carbon emissions increase if an interim storage facility is built? What does SSI have to say about this?

Henrik Efraimsson, SSI: We do not have any answers yet as to whether an interim storage facility is required for Barsebäck. If the question undergoes environmental review, the climate aspect should also be considered.

Johan Swahn, MKG: It appears as if there are two questions regarding final disposal that must be answered: Can SFR-1 be used for decommissioning waste from Barsebäck? Is there room in BFA? If the industry has no intention of doing certain things, the Government or the regulatory authorities can't do anything about it, and SKB gets its way. Can this be changed in any way?

Ingvar Persson, SKI: We are not powerless, but the industry has an obligation under the Nuclear Activities Act and the Environmental Code to remediate the site. If this is not done, the regulatory authorities can issue an injunction. This was done, for example, by the County Administrative Board in Västra Götaland in the question of remediation of the Ranstad facility pursuant to the Environmental Code. We have muscles, but they should be used in accordance with the intentions of the legislation and when needed.

Jan Carlsson, SKB: I don't know how much space is available in BFA. But the space that exists beyond SKB's share of BFA is OKG's share. OKG uses this for interim storage of its waste.

Henrik Efraimsson, SSI: BFA contains 5,000 m^3, but if others are to use the space a commercial agreement must be reached between OKG and those who need the space.

Kenneth Gunnarson, Opinion Group for Safe Final Disposal in Östhammar (OSS): The decommissioning waste has been an open topic since the 1980s. Why have the regulatory authorities allowed the industry to postpone SFR-3 and the LILW repository until now, so that Kävlinge Municipality is affected?

Henrik Efraimsson, SSI: We are talking about the extension of SFR-3. According to SKB's current plan, 2045 is the deadline for long-lived waste. We have questioned whether such a plan is reasonable. With present-day planning the long-lived waste that exists today and additional waste, for example from the decommissioning of Barsebäck, will have to be interim-stored for a very long time.

Saida Lâarouchi Engström, SKB: We are discussing here what the state and the regulatory authorities should do if the industry fails to act. But the owners have worked hard on planning. Dismantling a plant is merely the last in a long series of tasks. Most of the work involves consultations, planning, environmental impact assessment, evaluation and review. We have already started consultations for the extension of SFR. We would also like to have a quick dismantling and do not think it is ethical to shift the burden to future generations. But here we are discussing what a quick dismantling entails. We believe we are working towards the quickest dismantling possible.

Björn Hedberg, Swedish National Council for Nuclear Waste: Everyone clearly wants a quick dismantling, but that means different things to different parties. SKB wants to start dismantling in 2020, but a number of tasks have to be completed before then. What measures can be speeded up to make things go faster without compromising quality: the EIA process, consultations, the time needed by the regulatory authorities for review? How can we combine these things to achieve a good and speedy process?

Pia Almström, Kävlinge Municipality: We don't want to blame the power industry. We have had viewpoints on a premature decommissioning, and in the decision for a quick dismantling of Barsebäck no consideration was given to this or to the consequences, which we suffer from today. It isn't SKB's fault; the politicians should have made a closer study of the problems of decommissioning.

Kjell Mott, SERO: Is this about economics and underestimated costs? Is there any obstacle to increasing the fees paid to the Nuclear Waste Fund?

Staffan Lindskog, SKI: In 2010 or 2013, the EU will carry out calculations where final disposal and decommissioning are separated. Then a safety margin will be provided for decommissioning costs and we will have to see if this is enough.

Roland Davidsson, SERO: The industry has known that the politicians could order plant closure since the referendum on nuclear power. Why haven't they made plans for this during the 25 years

since then? All licensing processes should have been completed by this time.

Leif Öst, Barsebäck Kraft: If the industry is supposed to plan based on what the politicians say, there was nothing else we could do. A lot of political decisions have been made: In 1977 Barsebäck was not supposed to be started, in 1989 we had an "irrevocable decision", Barsebäck and Ringhals were to be stopped, and so on. Our goal is to operate the nuclear power plants as safely as possible. We act on the basis of firm decisions, not stated intentions. The question of when SFR-3 will be finished is based on concrete decisions.

Ditt Retman, MILKAS: The EU's reform treaty will soon enter into force. How will the treaty affect these activities? A worst-case scenario would be if the market can allow other countries to dispose of their waste in Sweden.

Ingvar Persson, SKI: The Nuclear Activities Act states that it is prohibited to dispose of radioactive waste from another country without a permit. If a permit is issued, it should only be for small quantities that are difficult to return to the country of origin. Studsvik has such a permit. But the prohibition is general and prohibits storage or disposal, and that is not affected by the new treaty. Furthermore, the Euratom Treaty is still in effect and is not affected.

Britta Kahaanpää, MILKAS: Barsebäck has paid money to the Nuclear Waste Fund to pay for the costs of all decommissioning. If the money in the fund is not enough for decommissioning, does E.ON have to pay, or is it Vattenfall via Barsebäck Kraft?

Leif Öst, Barsebäck Kraft: According to the existing agreement, E.ON is liable to pay.

Britta Kahaanpää, MILKAS: Waste is taken from decommissioning of nuclear power plants in Germany and driven to Studsvik every day. But it is not returned, but is transported after treatment to Östhammar. Is this true, and if so how much will be disposed of in Östhammar?

Henrik Efraimsson, SSI: Treatment in Studsvik involves incinerating combustible waste and melting metals. Incineration produces ashes and dust from filter systems, and everything is sent back to Germany. When scrap is melted, the remainder is pure metal that is reused in Sweden. The slag and other residual products that contain radioactivity go back to Germany. But, as Ingvar mentioned, Studsvik has an agreement to dispose of foreign waste in Sweden which applies to the parts that constitute secondary waste in the process. An example is if Studsvik replaces the furnace lining in the melting furnace, when it is not possible to differentiate whether the impurities are from Swedish or German atoms. They are therefore permitted to send this to the Swedish final repository. This involves small quantities of maybe a few tonnes.

Ola Jönsson, SERO: Is the water pool in Barsebäck emptied or is it overfilled as the rumours say? How is the pool used during decommissioning for handling high-level waste?

Leif Öst, Barsebäck Kraft: The fuel pools in the reactor hall are used as radiation protection. The high-level fuel was removed long ago. There is no other high-level material left in Barsebäck. The pools are filled with water because they are used as handling pools, but not for any high-level waste.

Per Hegelund, MILKAS: Independent scientists in France say that as much radiation is emitted during the dismantling of a nuclear power plant as during the entire lifetime of the plant. Dismantling is a critical phase. What does decontamination involve? Is it high-pressure cleaning? What happens with the waste water, how is it cleaned or where does it go?

Henrik Efraimsson, SSI: The water is cleaned in the existing waste treatment systems. You get ion exchange resins that contain radioactivity. How much is discharged to Öresund depends on the water treatment in Barsebäck.

Leif Öst, Barsebäck Kraft: All radioactive parts are dismantled before the buildings are demolished. All filters from exhaust air etc. are still radioactive. I don't have any figures on how much radioactivity is emitted, but all protective barriers are still in place. The last thing to be torn down is the building.

Decontamination entails the use of water containing chemicals to clean process systems. The water is then cleaned in filters. The filters are managed as operational waste and subsequently disposed of in SFR in Forsmark.

Lars Olof Höglund: Should SKB need 13 years to design an extension of SFR for decommissioning waste? It originally took 8 years to build the whole SFR, and it is a much more complex facility than the extension, which consists of a number of simple rock caverns.

Jan Carlsson, SKB: Blasting of tunnels and rock openings doesn't take longer today than it did 20 years ago. But we now have a different procedure with environmental impact assessments and consultations, which takes time. It therefore takes longer to build rock caverns than it used to take to build, for example, a nuclear power plant.

Saida Lâarouchi Engström, SKB: Today's environmental legislation with e.g. consultations did not exist when we built the nuclear power plants. What should we sacrifice: planning quality, safety of execution, site investigations, consultations, regulatory review?

We will approach this problem seriously, since we are dealing with a nuclear activity where safety must come first. Decommissioning and dismantling must be allowed to take time, just as in the case of a final repository.

Leif Öst, Barsebäck Kraft: I have participated in the preparation of environmental impact descriptions and an environmental review of nuclear activities for Ringhals and Barsebäck. The plants were built and in operation, but had to be brought into line with the new Environmental Code. The Ringhals project took five years and Barsebäck took four and a half years, and I don't think SFR will go faster than they did. If we were to build a new nuclear power plant it would take around 10 years.

Björn Hedberg, Swedish National Council for Nuclear Waste: Hans Rohde, former head of the Swedish Road Administration, has said that it is not possible to push through large projects in less than ten years, given the formal process that includes consultations. According to him, there is no great difference between one large project and another. SKB could perhaps shorten the time taken by

different steps, but the question is whether we want this if the result suffers?

Öivind Toverud, SKI: The site investigations for a KBS-3 final repository in Forsmark have taken 5 years and in Laxemar 3 years, and lots of data have been collected. How can it take five years to investigate an extension of SFR?

Staffan Lindskog, SKI: It is important to look at the review of RD&D 2004, where it says that an extension of the final repository (SFR) will be finished by 2020 and that this date will not be exceeded. Otherwise there may be problems.

Claes Thegerström, SKB: There has been a change in as much as we said 2020 at the earliest in RD&D 2004, while in RD&D 2007 we say 2020. The establishment and site investigations for the final repository for spent fuel were begun in 2001 and will result in applications in 2009. Then it will have taken 8 years. For the SFR extension we have said in the planning that the investigations will not be as comprehensive.

Henrik Efraimsson, SSI: I'm glad to hear that it's now 2020 and not 2020 at the earliest. It's important not to compress the timetable without achieving the goals. But it is possible to be more flexible in planning the decommissioning and dismantling process. Now we have discussed the options of interim storage or extension of SFR. But there is a range of different waste categories to be managed. Some parts can perhaps be released for unrestricted use quickly, while other parts must be interim-stored. We know today how the primary system should be packaged if it is dismantled. How much could be deposited after a relicensing of the existing SFR? How great is the problem of storing a certain type of waste on-site or somewhere else on the way to Forsmark? Here there are different alternatives to explore.

Björn Hedberg, Swedish National Council for Nuclear Waste summarizes the day by saying that there should be flexibility in the system and that many of the participants in the seminar would like to see how this flexibility can be used to influence the time for dismantling. But, he says, it may not be possible to make any major changes in the current timetable.

The Swedish National Council for Nuclear Waste – Kärnavfallsrådet – is an independent scientific committee within the Ministry of the Environment. Its mandate is to advise the Government in matters relating to nuclear waste and the decommissioning of nuclear installations. KASAM's members are experts within different areas of importance for the disposal of radioactive waste, not only in technology and science, but also in such areas as ethics, the humanities and the social sciences.

In the autumn of 2006, the Council launched a new transparency programme aimed at strengthening the Council's role as an advisor to the Government by shedding light on strategic issues. Hearings and seminars aimed at clarifying facts and values in current issues will be central features. The programme should also serve as a resource for other stakeholders in the future licensing process.

A pilot study for the transparency programme revealed high expectations on the part of central actors in the nuclear waste issue. Among other things, a need was found for a thorough elucidation of questions concerning the decommissioning of nuclear facilities. The Swedish National Council for Nuclear Waste therefore held a hearing on this topic on December 11, 2007.

The purpose of the hearing is to accumulate knowledge on the planning and execution of decommissioning of nuclear facilities. Some of the topics that were discussed were:

- the owner's plans for decommissioning of the Barsebäck plant,
- SKB's plans for managing and disposing of the radioactive waste and the requirements of the supervisory authorities,
- the concerned municipalities' needs and viewpoints,
- costs and financing,
- the decision process including the EIA procedure.

This report contains presentations and discussions from the hearing and concludes with an analysis of the arguments proffered by various actors.

This report and the presentations from the hearing are available on our website www.karnavfallsradet.se. They can also be ordered from the secretariat of the Swedish National Council for Nuclear Waste.

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