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# SKI Perspective

## Background

The Swedish Nuclear Power Inspectorate (SKI) is responsible for regulating decommissioning of nuclear power plants in Sweden. SKI was faced with 1) the oversight of the decommissioning of the first plant to permanently close in Sweden, 2) the identification of key safety issues during decommissioning, and 3) the development of a long-term strategy for regulating all phases of decommissioning of nuclear power in the future. SKI has completed a number of studies and regulatory activities in carrying out these responsibilities.

## Purpose of project

The purpose of this project is to create a report that documents some of SKI's decommissioning activities and that will:

- assist SKI in evaluating regulatory policies on decommissioning,
- inform SKI staff on decommissioning activities and safety issues, and
- provide information on SKI's approach to regulation of decommissioning to others—including the Swedish public, the Swedish nuclear power industry, other Swedish regulators and nuclear regulators from other countries.

## Results

The report identifies organizational and human factors safety issues that can arise during decommissioning and discusses the initial regulatory actions of SKI regarding the decommissioning of Barsebäck Unit 1. It also provides summaries of SKI-sponsored studies on decommissioning issues.

## Continued work

This report provides information useful for further development of SKI's regulatory policy, staff training, and support for inspection activities for decommissioning. The report points out that an area needing further study is the identification of how safety issues have emerged and are likely to emerge during different phases of decommissioning (e.g. deactivation of systems, dismantling of major structures).

## Effects on SKI work

SKI will use the information in this report in further developing its knowledge of decommissioning issues and for providing guidance to SKI staff regarding decommissioning oversight.

## Project info

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# Summary in English

In the late 1990's the Swedish government decided to shut down Unit 1 of the Barsebäck nuclear power plant. This report documents some of the efforts made by the Swedish Nuclear Power Inspectorate (SKI) to address human factors and organizational issues in nuclear safety during decommissioning of a nuclear facility.

This report gives a brief review of the background to the decommissioning of Barsebäck 1 and points out key safety issues that can arise during decommissioning.

The main regulatory activities that were undertaken were requirements that the plant provide special safety reports on decommissioning focusing on first, the operation of both units until closure of Unit 1 and second, the operation of Unit 2 when Unit 1 was closed. In addition, SKI identified areas that might be affected by decommissioning and called these areas out for special attention.

With regard to these areas of special attention, SKI required that the plant provide monthly reports on changing and emerging issues as well as self-assessments of the areas to be addressed in the special safety reports.

Ten key safety issues were identified and evaluated with regard to different stages of decommissioning and with regard to the actions taken by Barsebäck. Some key conclusions from SKI's experience in regulating a decommissioning nuclear power plant conclude the report.

# Summary in Swedish

Mot slutet av 1990-talet beslutade den svenska regeringen att Barsebäck 1 skulle stängas. Denna rapport dokumenterar en del av det arbete som SKI har gjort för att utreda organisatoriska och mänskliga säkerhetsaspekter vid avveckling av kärntekniska anläggningar. Vidare behandlas på vilket sätt säkerhetstänkandet påverkar den anställda och organisationen vid nedläggning av ett kärnkraftverk.

Rapporten ger en redovisning av bakgrunden till nedläggningen av Barsebäck 1 och pekar på centrala säkerhetsfrågor som kan uppkomma under en nedläggning.

Det huvudsakliga tillsynsarbetet handlade om krav på att Barsebäck Kraft AB skulle ta fram speciella säkerhetsrapporter om nedläggningen med fokus på driften av de två reaktorerna under tiden fram till nedläggningen av Barsebäck 1, och vidare med fokus på driften av Barsebäck 2 när Barsebäck 1 hade stängts av. Därutöver identifierade SKI ytterligare områden som skulle kunna påverkas av nedläggningen och pekade ut dessa för att ges speciell uppmärksamhet.

SKI ställde därutöver krav på att Barsebäck skulle sammanställa månatliga rapporter inom dessa områden och redovisad dem skriftligen till SKI. Rapporten skulle utöver nämnda områden innehålla förändringar som skett och uppkommande nya frågeställningar. Vidare skulle det framgå i rapporterna deras egna värderingar av de redovisade områdena.

I rapporten identifierades och utvärderades tio centrala säkerhetsområden med avseende på olika nedläggningsstadierna och med avseende på de åtgärder som hade vidtagits av Barsebäck. Till sist har SKI lyft fram några viktiga slutsatser från SKI:s erfarenhet av tillnyen av ett verk som läggs ner.

# 1. Introduction

In the late 1990's the Swedish Nuclear Power Inspectorate (SKI) was faced with regulating a decommissioning plant for the first time when the Swedish government decided to shut down Unit 1 of the Barsebäck nuclear power plant. SKI addressed three types of issues regarding this change—human factors and organizational issues, technical issues, and nuclear waste issues. SKI took actions in all three of these areas. This report documents SKI's response to human factors and organizational issues.

SKI had three foci for addressing human factors and organizational issues of decommissioning:

- Oversight and safety assurance during the period prior to and after shutdown of Unit 1 of the Barsebäck nuclear power plant
- Identifying and addressing the regulatory issues that were likely to arise regarding oversight of all stages of decommissioning and
- Identifying and responding to the safety issues that were likely to arise as a consequence of all stages of the decommissioning process.

SKI developed an immediate plan of action and engaged in many inspection activities and discussions with the licensee concerning decommissioning in order to assure safety prior to and after shutdown of Unit 1 of Barsebäck. At the same time SKI began developing a long-term regulatory approach for decommissioning and pursued research on the regulatory and safety issues created by decommissioning. As research identified new issues, these were brought to the attention of SKI staff responsible for the decommissioning issues and inspection of Barsebäck and to the attention of the management and staff at Barsebäck.

Since there was no experience with decommissioning Swedish nuclear power plants, SKI began actively looking for relevant Swedish experience with organizational and human factors issues when shutting down other types of facilities and relevant international experience on decommissioning nuclear power plants. In order to learn from the experience of others, SKI sponsored a number of projects to identify key safety and regulatory issues and actively participated in international workshops and conferences on decommissioning. SKI obtained a great deal of information on significant issues through literature reviews, interviews, and international workshops. Based on this information, SKI adjusted its oversight and regulatory approach. This report describes decommissioning oversight during the initial decommissioning of Barsebäck and research activities and findings regarding human factors and organizational issues related to decommissioning.

This report:

- Briefly reviews the background to the decommissioning of Barsebäck, the initial actions of SKI, and major research activities in Section 2.0.
- Discusses the development of a long-term regulatory approach for decommissioning in Section 3.0.
- Lists and discusses key safety issues that can arise during decommissioning, including an initial analysis of how safety issues have arisen or may arise during different stages of decommissioning in Section 4.0.

- Provides a description of the activities and current status associated with each of the key safety issues at Barsebäck in Section 5.0.
- Gives some key comments and conclusions in Section 6.0
- Presents more detail on the research activities and findings in Appendix A.

## **2. Background, Initial Actions and Research**

In Sweden the Nuclear power industry has faced an uncertain future since the 1970's when nuclear power became the focus of political controversy. This led to a referendum in 1980 on the future of the Swedish nuclear power program. Based on public support for phasing out nuclear power, parliament decided to not to begin any new building of nuclear power plants and to eventually phase out reliance on nuclear power in Sweden. The schedule for starting the decommissioning of nuclear power plants in Sweden has changed several times. In the spring of 1997, the Swedish Parliament adopted a bill on energy policy entitled "A Sustainable Energy Supply". This proposal included the closure of the boiling water reactor Barsebäck Unit 1 as the first reactor to be decommissioned. After a court decision, Barsebäck Unit 1 was shut down in November of 1999. In 2001 Parliament stated that further nuclear power plant closures would be decided based on an evaluation of energy supply needs. It is anticipated that no decision or action on the closure of Barsebäck Unit 2, or any other nuclear facility, will occur before 2003.

The Swedish law on Nuclear Activities establishes legal authority of SKI in regulating nuclear power plants. This authority applies to decommissioning as well as operating nuclear power plants. The licensee for the nuclear facility retains full responsibility for safety for all phases including plant closure and final disposal of nuclear waste. The owners of the facility are responsible for all costs of closure and final waste disposal. Resources are set aside on an ongoing basis for these expenses.

When the parliament adopted the new energy policy in 1997, SKI began activities to identify potential human and organizational safety-related impacts as one part of its preparation for effective regulation of the decommissioning process. It was found that very little information was available on the organizational and human factors aspects of nuclear power plant closures (see literature reviews by Lundquist and by Melber prepared in 1998). In contrast, substantial research and analysis regarding the technical requirements for shutdown and decommissioning have been conducted. (For example, the Nuclear Energy Agency (NEA) of the Organization for Economic Cooperation and Development (OECD) has established a project for exchange of technical experience and for the development of new methodologies for decommissioning nuclear power plants.)

SKI began by immediately assessing and responding to the potential safety consequences of the decision to shut down a nuclear power facility. At the same time it started to develop a long-term strategy for the regulation of decommissioning. Because there was limited information on the risk and safety issues during decommissioning from an organizational and human factors perspective, research was required to collect information on the most effective regulatory strategies. Hence, SKI was concurrently 1)

identifying and addressing any immediate safety issues, 2) developing an overall long-term approach to regulation and 3) obtaining more information on organizational and human factors safety issues during decommissioning. These three activities are discussed in more detail below.

## **2.1 Identifying and Addressing Immediate Safety Issues**

One of the first steps in developing the regulatory strategy for oversight of Barsebäck was an evaluation of the potential consequences of the basis for the decision to decommission. The basis for the decision to shut down Barsebäck differed from most decisions to shut down nuclear power plants in other countries. The decision to shut down Barsebäck was political—the result of a government decision in response to the 1980 referendum on nuclear power—in contrast to most shut down decisions which have been based on economic or safety considerations. In addition to the political nature of the decision, it was also a decision that dragged on for a lengthy period of time. The government proposal for shutdown was in 1997; the final decision and shutdown of Barsebäck Unit 1 was in November of 1999. A final decision regarding shutdown of Barsebäck Unit 2 will not be made until at least 2003. SKI identified two safety issues related to the nature of the decision-making in the shutdown of Barsebäck Unit 1. First, the plant was operating under high uncertainty since the initial proposal for shutdown in 1997. Second, there was a high potential for reduced motivation among staff and a loss of key staff during the decision-making period.

During the decision-making period SKI established requirements for Barsebäck to meet prior to shutdown. SKI required that the plant provide special safety reports on decommissioning focusing on first, the operation of both units until closure of Unit 1 and second, the operation of Unit 2 when Unit 1 was closed.

In addition, SKI identified areas that might be affected by decommissioning and called these areas out for special attention. These included:

- The organizational consequences of the shutdown
- The staff competence and motivation
- The plant safety culture
- The safe operation of the site
- The maintenance of the site
- The safeguards and physical protection of the site
- The strategies to be used for decommissioning

With regard to these areas of special attention, SKI required that the plant provide monthly reports on changing and emerging issues as well as self-assessments of the areas to be addressed in the special safety reports.

SKI also developed a plan for immediate regulator actions following the shutdown. The plan included that:

- Two SKI staff would be on site at the time the decision was made
- SKI would be prepared for remaining on site as long as was needed to assure safety

- Within six months of Unit 1 closure SKI would conduct inspections on
  - The decommissioning situation
  - Staff competence
  - Human factors and organizational issues
- SKI would establish new requirements as needed

After Barsebäck shut down, SKI required that the special safety reports be updated and that the monthly reports and meetings continue. In addition, SKI increased inspections and site visits during which they focused on identified safety issues. As part of the inspection activities, SKI engaged a consultant to create a detailed record of emerging decommissioning issues.

## **2.2 Development of a Long Term Strategy**

Decommissioning is a new phase in the life cycle of nuclear power plants and creates new regulatory issues, including

1. Setting the appropriate priority for decommissioning oversight;
2. Developing an organizational strategy for regulating decommissioning;
3. Obtaining and developing necessary staff expertise for oversight of decommissioning;
4. Determining and developing a regulatory framework for oversight of decommissioning.

Each of these issues is discussed briefly here. In Section 3 the fourth area, determining and developing a regulatory framework for decommissioning, is discussed in more detail.

### **2.2.1 Setting the Appropriate Priority for Decommissioning Oversight**

SKI staff made an initial assessment of risks and safety issues related to decommissioning. In general, the safety risks of decommissioning differ from those during operations; most significantly, the risk of a catastrophic accident decreases as soon as the fuel is removed from the reactor vessel. Other safety concerns, such as radiological contamination of workers and the environment during deactivation of systems, deconstruction and transfer and storage of waste materials, represent new or increased areas of risk that need evaluation and control.

### **2.2.2 Developing an Organizational Strategy for Regulating Decommissioning**

In order to develop and implement an organizational strategy for regulating decommissioning, responsibilities need to be assigned to relevant departments and agencies (within SKI and SSI). In addition, regulators need to decide whether or not new departments are needed to address specific aspects of decommissioning. A major task is to reconcile regulatory and other policies and demands across government agencies to establish a clear understanding of the roles of the various agencies overseeing decommissioning. It is important to assure that responsibilities are not

duplicated and that gaps in authority do not exist. A number of meetings within SKI and between SKI and other agencies were held to develop organizational strategies.

### **2.2.3 Obtaining and Developing Necessary Staff Expertise for Oversight of Decommissioning**

Decommissioning activities vary from those of operations in important ways. Staff with extensive experience with operating reactors may need to be trained in issues of decommissioning. These include new technical areas (e.g. deconstruction), new organizational and human factors issues (e.g. maintaining key staff and staff expertise, maintaining organizational viability), and new regulatory issues (e.g. any new regulations and relationships with other regulators with regard to decommissioning).

### **2.2.4 Determining and Developing a Regulatory Framework for Oversight of Decommissioning**

The establishment of an underlying framework to be used by the regulator during the decommissioning process is necessary to address the other regulatory issues. This framework includes the legal basis for regulation, the knowledge of safety concerns brought to bear on decommissioning by the regulator, and the decisions regarding what will be the regulatory foci during decommissioning activities. This is discussed more fully in Section 3.0.

## **2.3 Obtaining Information on Organizational and Human Factors Safety Issues During Decommissioning**

SKI carried out a number of research activities in the area of organizational and human factors safety and regulation during decommissioning during the period from 1997 until 2001. Table 1 presents a chronology of the main activities conducted and the products that were produced during this period. A more detailed discussion of these activities and their products is provided in Appendix A to this report.

As a result of these activities SKI was able to identify key organizational and human factors safety issues for decommissioning and to focus on these safety issues in the oversight of the closure of Barsebäck Unit 1. In addition, SKI used and continues to use these safety issues in developing its long term planning for regulation of decommissioning in Sweden.

**TABLE 1: DECOMMISSIONING RESEARCH ACTIVITIES AND PRODUCTS**

<i>Year</i>	<i>Key Activities</i>	<i>Products</i>
1997	<i>SKI commissioned project to interview U.S. NRC Inspectors with experience with decommissioning</i>	<i>SKI Report 98:3: <u>U.S. Experience with Organizational Issues during Decommissioning</u> by Durbin and Harty</i>
1998	<i>SKI commissioned literature reviews on organizational and human factors issues in decommissioning, sponsored an international workshop <u>Decommissioning and the Interaction of Man, Technology and Organization</u> held in Saltsjobaden, Sweden and sponsored a project on the potential effects of uncertainty on workers.</i>	<i>SKI Report 98:13: <u>The Milieu for Decommissioning in Sweden</u> by Lundqvist (in Swedish). <u>Articles on MTO Issues in Decommissioning: United States, United Kingdom and Japan</u> by Barbara Melber. Article/ SKI Report 99:56 <u>Review of European Literature on Decommissioning</u> by Lundqvist (in Swedish). SKI Workshop: <u>Decommissioning and the Interaction of Man, Technology and Organization</u> Paper/SKI Report 01:42: <u>Potential Effects of Organizational Uncertainty on Safety</u> by Durbin, Lekberg and Melber, <u>Proceedings of the International System Safety Society 09-98</u></i>
1999	<i>SKI participated in a CSNI workshop <u>Nuclear Power Plant Transition from Operation into Decommissioning: Human Factors and Organizational Considerations</u> in Rome Italy and sponsored two research efforts, which resulted in papers presented at the workshop.</i>	<i>The SKI MTO manager, Gerd Svensson, chaired the CSNI workshop and took the lead in preparing the report on the meeting published by CSNI Papers sponsored by SKI: <u>Decommissioning as an Organizational Process</u> by Lundqvist and <u>Regulatory, Organizational and Technical Processes of Decommissioning</u> by Melber and Durbin</i>
2000	<i>SKI supported work on diagramming decommissioning processes in order to improve understanding of how safety issues might emerge over the course of decommissioning.</i>	<i>SKI held meetings on using diagramming as a tool to describe decommissioning processes with staff from the MTO department and from the office of Nuclear Waste Management in May.</i>
2001	<i>SKI supported a summary of key safety and regulatory issues identified by SKI activities and research and an interpretation of the applicability of the SKI general regulation (SKIFS: 1998) to decommissioning. Prepared materials for IAEA meeting on decommissioning</i>	<i>Letter reports: <u>Decommissioning Nuclear Power Plants: Identifying and Addressing Safety and Regulatory Issues</u> by Durbin and Melber; <u>Implications of the General Regulation (SKIFS) for Decommissioning</u> by Melber and Durbin; <u>Guidance for decommissioning</u> by Melber and Durbin Presentation materials: <u>Regulating Decommissioning in Sweden</u> by Lekberg SKI Report: <u>Decommissioning: Regulatory Activities and Identification of Key Organizational and Human Factors Safety Issues</u> by Durbin, Melber, and Lekberg</i>

### **3. Developing a Regulatory Framework for Oversight of Decommissioning**

In this section we discuss three components of a framework for the oversight of decommissioning. For each component we briefly discuss both some things SKI is already doing as well as provide ideas regarding possible future developments.

The three components of the framework are:

- The existing law, regulations and policies that set boundaries on how plants are allowed to carry out decommissioning.
- Information from the experience of regulators and plants both inside and outside of Sweden that identifies safety concerns, regulatory strategies, and potential solutions to problems.
- The regulatory strategy for assuring safety during utility and plant conduct of decommissioning.

#### **3.1 Existing Law, Regulations and Policies that Set Boundaries on Decommissioning Actions by the regulator and the licensee**

Some boundaries (limits) with regard to decommissioning actions by the regulator and by the licensee are established either by Swedish law or by requirements of regulatory agencies. For example, under Swedish law the licensee is responsible for the full cycle of nuclear power production, including decommissioning and nuclear waste storage and disposal. Based on this responsibility, licensees are required to set aside in advance sufficient resources for carrying out and completing decommissioning.

Reviewing existing regulations that have implications for plants undergoing decommissioning is an important initial step for clearly specifying and communicating to licensees the demands they must meet. This is not a simple task, since regulations that have implications for decommissioning are scattered across a number of regulatory agencies (primarily, but not limited to, SKI and SSI) and are imbedded in general regulations often originally developed for operating plants. Some examples include demands regarding transportation of spent nuclear fuel and interim nuclear waste storage requirements (SKI) and limits on radiation dose levels for workers (SSI). SKI has begun the review of the recent general regulation (SKIFS: 1998) to determine what demands in this regulation are applicable to licensees when they decommission a nuclear power plant.

Generally, this component addresses the need to map out what requirements already have been established. This information clarifies current demands on licensees and provides a baseline for determining if additional requirements regarding decommissioning need to be developed.

## **3.2 Information from the Experience of Regulators and Plants both Inside and Outside of Sweden to Identify Safety Concerns, Regulatory Strategies, and Potential Solutions to Problems**

An important step in developing regulations for a new activity area, such as decommissioning, is to gather relevant knowledge and experience. The identification of relevant safety issues can help focus the regulator on key risk areas and help in assessments of a plant's plans and actual implementation of activities. A list of significant safety issues can serve as a guide to technical staff and inspectors for selecting areas to evaluate on plant document reviews and inspections of plant activities. In addition, it can provide guidance to plants on areas they need to address in developing their own plans and conducting independent safety reviews of their activities. A more complete discussion of these issues is provided in Section 4.0.

As discussed above, SKI began this component several years ago by sponsoring research on decommissioning, developing and hosting a workshop on decommissioning issues in Sweden in May 1998, and chairing the CSNI workshop on organizational issues in decommissioning in May 1999. SKI is continuing this work through ongoing participation in the CSNI task force that includes decommissioning issues in its mandate and through participation in international conferences, such as the October 2001 International Atomic Energy Agency (IAEA) meeting on decommissioning.

Future work suggested at the SKI and CSNI workshops might include establishment of an "experience feedback" program for decommissioning. This program would provide an ongoing system to identify both new safety issues as they arise as well as "best practices" to address potential problems that have been found successful. The program could be modeled on operating experience feedback programs used in Sweden and other countries or on the international exchange project of NEA on technical experience and methodology development for decommissioning.

## **3.3 Regulatory Strategy for Assuring Safety During Utility and Plant Conduct of Decommissioning.**

This component of the framework is how the regulator uses the current law, regulation, and policies (component 1, above) combined with the information and experience gathered on decommissioning safety (component 2, above) in a strategy to assure safety during decommissioning of a nuclear power plant. SKI is currently in the process of further developing and refining the strategy for regulation of decommissioning nuclear power plants.

## **4. Discussion of Key Organizational and Human Factors Safety Issues**

The SKI and CSNI workshops identified important organizational and human factors safety issues based on reports, information presented at these workshops, and discussions among the participants. The identification of relevant safety issues helped to focus the regulator on key risk areas and in assessments of a plant's plans and actual implementation of activities. It can serve as a guide to technical staff and inspectors for selecting areas to evaluate on plant document reviews and inspections of plant activities. In addition, it can provide guidance to plants on areas they need to address in developing their own plans and conducting independent safety reviews of their activities.

In this section we present a summary of the key organizational and human factors safety issues that were identified as emerging during decommissioning (4.1) and a discussion of how some of these issues may emerge during different stages of decommissioning (4.2).

### **4.1 Key Safety Issues During Decommissioning**

Key organizational and human factors safety issues were identified during SKI activities based on reports, information presented at the SKI and CSNI workshops and discussions among workshop participants. The key organizational and human factors safety issues that were identified as emerging during decommissioning were:

- 1) Obtaining and retaining staff competence during decommissioning
- 2) Sustaining organizational memory
- 3) Identifying key organizational functions and management skills that are critical during the transition from operations to decommissioning
- 4) Sustaining organizational viability and accountability for decommissioning
- 5) Sustaining safety culture and morale
- 6) Overseeing contractor work
- 7) Decommissioning a multi-unit site when one unit continues to operate
- 8) Delaying dismantling of decommissioned nuclear power plants
- 9) Establishing organizational processes and control systems to identify and address emerging as well as known safety issues
- 10) Determining and communicating the level of risk during decommissioning.

These 10 issues are presented with more detail below.

1. Obtaining and retaining staff competence during decommissioning
  - Identifying expertise needed to conduct decommissioning tasks;
  - Identifying and/or developing training resources;
  - Attaining needed competence: retaining and re-training current staff and recruiting new staff.

2. Sustaining organizational memory
  - Identifying the content that needs to be preserved and transferred to those conducting decommissioning activities;
  - Transferring plant-specific knowledge—e.g. physical history of systems and changes (such as locations) and history of how and why changes were made (such as maintenance changes, upgrades and retrofits);
  - Preserving identified content for the future;
  - Developing and implementing systems for easy retrieval of information in the future.
3. Identifying key organizational functions and management skills that are critical during the transition from operations to decommissioning
  - Identifying organizational structures and processes needed for the transition from operations to decommissioning;
  - Managing the transition (management of change).
4. Sustaining organizational viability and accountability for decommissioning
  - Assuring sufficient resources are available to carry out all phases of decommissioning;
  - Assuring a viable organization continues to function that has responsibility and accountability for decommissioning—including a clear establishment of who the licensee is throughout the entire process of decommissioning (e.g. changes of ownership may occur at some points during the period of completion of all stages of decommissioning).
5. Sustaining safety culture and morale
  - Reducing uncertainty for workers;
  - Maintaining trust in management.
6. Overseeing contractor work
  - Establishing an effective oversight process;
  - Assuring contractor and subcontractor management and staff have an appropriate understanding of risks and conduct activities with proper safety behavior.
7. Decommissioning multi-unit sites when one unit continues to operate
  - Potential risks of decommissioning to operating unit due to shared systems;
  - Tendency to give operating unit higher priority in terms of staffing, conducting necessary maintenance and safety tasks, etc.
8. Delaying dismantling of decommissioned nuclear power plants
  - Degradation of knowledge and understanding of the level of risk over time—future generations may “not know that they don’t know” the risks, and assume risks are lower than they really are;
  - Insufficient financial resources for completing dismantling of the plants.

9. Establishing organizational processes and control systems to identify and address emerging as well as known safety issues
  - Radiation protection of workers under different conditions than operations;
  - Hazards analysis and response plans for new scenarios of potential accidents;
  - Quality system and safety processes for decommissioning tasks.
10. Determining and communicating the level of risk during decommissioning.
  - New areas of activity create different types of risk (there may be a recognition that operating risks have diminished without a concomitant recognition of new risks associated with decommissioning);
  - Workers competent in decommissioning activities (e.g., deconstruction) may not have appreciation for radiation and other types of risks when deconstructing a nuclear facility.

## **4.2 Assessing Key Organizational and Human Factors Safety Issues During Phases of Decommissioning**

Four phases that cover a licensee's major responsibilities for decommissioning were identified:

1. Develop strategy for decommissioning;
2. Conduct decommissioning activities on site;
3. Transfer nuclear materials off site;
4. End license of facility and release site.

Each of these is presented in more detail below.

### **1. Develop strategy for decommissioning**

- Set aside sufficient resources for completion of all decommissioning activities
- Determine timing of dismantlement after plants shut down and removal of fuel from reactor (e.g. immediate, short term delay—under 5 years, long term delay—30+ years)
- Prepare initial plan for decommissioning activities

### **2. Conduct decommissioning activities on site**

- End operations and shut down plant
- Deactivate systems
- Transfer fuel from reactor to spent fuel pool
- Dismantle facility

### **3. Transfer nuclear materials off site**

- Transfer spent fuel to interim storage
- Transfer low level nuclear waste to storage

### **4. End license of facility and release site**

- Clean and repair site
- Conduct final radiation survey

- Release site for unrestricted use

Below, for each phase, we discuss some of the key organizational and human factors safety issues and provide some examples of how these issues are likely to emerge under each phase.

#### 4.2.1 Develop Strategy for Decommissioning

The preparation of an initial plan for decommissioning is critical to the safety of the entire process. Experience at U.S. plants has demonstrated the importance of having a plan for addressing the safety issue *Obtaining and retaining staff competence during decommissioning* well before the final closure of the plant. The uncertainty surrounding the plant prior to decommissioning can lead to early resignations by key personnel. Plans for *sustaining organizational memory* also need to be in place (and to a certain extent implemented) early in the process. Well run operating plants will have excellent documentation—but as discussed in the CSNI workshop, even excellent plant documentation is not complete; critical organizational memory resides with plant personnel. Documentation that may not have been of major importance during operations (e.g., original building plans and modification drawings) because “everyone knows where things are and what changes have been made” must be in good order to reduce unforeseen problems during dismantlement. One of the most important areas is assuring that information relevant to decommissioning not only exists but is readily accessible to those in the field—having accurate drawings is worthless if they are not available when decisions are being made about the approach to tear down. Setting up these systems needs to be done early in the decommissioning process.

Two main approaches have been used in setting up the new management for decommissioning a plant—both require *Identifying key organizational functions and management skills that are critical during the transition from operations to decommissioning*. In one approach the management team that has been operating the plant is also responsible for planning for and implementing decommissioning. Under this approach there is a lot of consistency in management but the management team is dealing with two very different activities (running a plant and planning for decommissioning) at the same time. The other approach creates a separate team to plan for decommissioning and then to take over after the plant shuts down. Some combination of these approaches may be most common (e.g., there is a separate manager assigned to overall planning for decommissioning who is supported by a team of people who are still involved in operations).

Regardless of the approach, the team must *identify the organizational structures and processes needed for the transition from operations to decommissioning, establish organizational processes and control systems to identify and address emerging as well as known safety issues, and determine and communicate the level of risk during decommissioning*. For example, the plan should include the recognition that there will be an increased need for radiation protection support (especially during dismantlement) but the functions of operations crews will be greatly reduced.

Plans to *decommission a multi-unit site when one unit continues to operate* require special attention to the issues of shared systems that may limit the types of decommissioning activities that can be carried out.

The SKI review of a plant's initial plan can use the key safety issues discussed above as a guide for evaluation. For example, a plant may submit a plan that presents a new organizational structure and a list of positions the plant intends to implement at the time of cold shutdown but does not address how it will make the transition from its current operational structure. In this case the plant has not addressed such safety issues as *Identifying key organizational functions and management skills that are critical during the transition from operations to decommissioning* or *Obtaining and retaining staff competence during decommissioning*.

The use of the list of safety issues provides a way for the regulator to look at the specifics of a plan in terms of potential safety impacts. Concerns about a plan can be clearly articulated in terms of links to potential safety problems. This approach should provide a way of keeping the focus on a set of safety implications and not emphasizing the complex details of a plan (and possibly losing sight of the “bigger picture”).

#### **4.2.2 Conduct Decommissioning Activities on Site**

One critical issue that the regulator will need to attend to during this active decommissioning phase is whether the organization responsible for the plant will be able to *sustain organizational viability and accountability for decommissioning*. Once a plant is shut down, it no longer contributes to the company and costs escalate—there is little financial incentive to maintain attention towards the plant or to keep adequate organizational resources to finish the job. Owners and operators may attempt to set up “dummy” organizations that divorce the main organization from the responsibility—both fiscal and safety—of completing decommissioning.

*Sustaining safety culture and morale* is also a priority throughout decommissioning. The early period, in particular, is one of high uncertainty among workers. Although the early phase is probably the period of greatest vulnerability for the safety culture and morale of workers, long term attention to safety culture and morale is necessary over the entire period of decommissioning.

The success of decommissioning activities will be highly dependent on whether the site effectively implements its plans for *obtaining and retaining staff competence during decommissioning* and *sustaining organizational memory*. It is during deactivation of systems and dismantling the facility that problems are most likely to arise concerning inadequate or inaccurate knowledge of current system status and past modifications.

*The use and control of contractors* becomes increasingly important as decommissioning continues because of the typical pattern of greater reliance on contractors particularly when dismantling the facility. Two aspects of particular concern are the need for plant staff to maintain sufficient expertise to assess the work conducted by contractors and the potential for reduced adherence to and understanding of safety requirements by contract staff not steeped in an established nuclear safety culture. This latter issue is related to the plant's success at *effectively communicating the level of risk during decommissioning*.

A major issue when *decommissioning a multi-unit site while one unit continues to operate* is the tendency to give the operating unit higher priority in terms of staffing, conducting necessary maintenance tasks and safety reviews. In the U.S. significant

problems arose during decommissioning at a multi-unit site due to lack of adequate attention to the shut down plant by both the licensee and the regulator.

Finally, *assuring that established organizational processes and control systems are effectively identifying and addressing emerging as well as known safety issues* may be one of the most difficult issues to deal with because of the relatively limited experience with decommissioning to date. Some type of experience feedback system is one way to be proactive in identifying potential problems early on.

The list of safety issues highlighted above suggests a scope for organizational and human factors inspections of plants while they are conducting decommissioning activities on site. Given the myriad of complex activities taking place, this focus is a useful way to assure that plants emphasize safety issues and that the regulator can articulate any concerns with safety performance. For example, a review of how the plant has addressed *the use and control of contractors* and how it has *communicated the level of risk during decommissioning* to both contractor and permanent plant staff would reveal the extent of systematic, preventive attention to staff understanding and following safety rules.

### **4.2.3 Transfer Nuclear Materials Off Site**

While plants routinely transfer nuclear materials off site, the magnitude and nature of the materials to be transferred changes during decommissioning. In particular the materials from dismantling the facility have more volume and weight than waste during operations. They may also be more radioactive than the low-level waste during operations—while still not qualifying as high-level waste. Problems of waste storage have been the major focus of attention regarding this waste; however, problems have arisen in the U.S. with regard to maintaining control over these radioactive materials. Since some materials are non-radioactive (e.g., the waste from dismantling a training facility) it can be difficult to maintain radiation checks on all materials leaving the site. Mishandling of waste that is radioactive has also been a problem. *Determining and communicating the level of risk during decommissioning* is thus a significant safety issue during this phase particularly because there is considerable variation in the level of radioactivity in the materials being transferred.

The staff used for transferring waste from the site, particularly during dismantling of the facility (rather than for transfer of spent fuel), may not have much experience with issues of radiation safety so *obtaining and retaining staff competence during decommissioning* becomes an important safety concern. The potential reliance on contractors to conduct these activities means *sustaining safety culture and morale* and *the use and control of contractors* are likely to be relevant concerns.

Of course, if the facility is *decommissioning multi-unit sites when one unit continues to operate* the management of the transfer of materials off site will have to assure that the operating facility is not affected.

While there is a narrower set of organizational and human factors issues to focus on concerning these activities, the recognition of specific safety concerns is important. Again, the identification of relevant safety issues for each phase contributes to a strategy for assuring that the regulator's oversight of decommissioning is thorough and effective.

#### **4.2.4 End License of Facility and Release Site**

At this point the safety issues are largely dependent on how the earlier stages have been accomplished. If *Obtaining and retaining staff competence during decommissioning* and *sustaining organizational memory* have been adequately addressed throughout the process, then it will be much easier to conduct the final site survey to determine that the site is clean and ready for release.

*Determining and communicating the level of risk during decommissioning* continues to be an issue. Preparation for site release is dependent on confidence that the level of risk for use of the site is well understood and well documented.

Regulator evaluation of organizational and human factors safety concerns at this point can primarily focus on these three critical issues.

## **5. Response of Barsebäck and SKI to Key Safety Issues Prior to and During Initial Stages of Decommissioning**

In this section we provide a brief summary of the activities taken by SKI and Barsebäck with regard to each of the safety issues discussed in earlier sections.

### **5.1 Obtaining and Retaining Staff Competence**

In response to concerns that key staff would leave while their skills were still needed for the safe operation and, then, decommissioning of Barsebäck, Barsebäck provided a five-year guarantee of employment for all staff. In addition, Barsebäck made an initial review of competence needed and availability of staff for the first phase of decommissioning. SKI requires a monthly report from Barsebäck evaluating the current status of staff competence and SKI and Barsebäck discuss staff competence at monthly meetings. In addition, SKI conducts inspections of the system that Barsebäck uses to assure staff competence.

## **5.2 Sustaining Organizational Memory**

Barsebäck addressed two primary sources of information on organizational memory, documentation and staff knowledge. Barsebäck conducted a quality audit and assessed the status of documentation to assure adequate written organizational memory. Also a program to obtain information from staff leaving the plant was implemented. SKI reviews these assessments and this program.

## **5.3 Assuring Adequate Organizational Structure for Decommissioning**

Barsebäck analyzed alternative ways of organizing the work for decommissioning and produced a plan for a new organization. The transition to the new organizational system was in May of 2000. SKI reviews and provides feedback on all proposed organizational changes that may impact safety. For example, SKI required that Barsebäck develop a procedure for organizational change and required an analysis of control room staffing.

## **5.4 Sustaining Organizational Viability and Accountability**

When plants decommission there is a risk that the organization will lose staff and/or resources to the point that it is no longer able to conduct necessary work and maintain safety. In addition, since the plant is no longer producing power, it may be difficult to assure that there is an adequate organizational presence to maintain accountability for safety and financial costs. At the time of this report discussions are under way between the Swedish government and owners of Barsebäck about alternatives for the possible transfer of the license for the nuclear power plant to a new organization. In addition, there are plans for mergers among power plant owners. SKI's role in this process is to review proposed changes and to advise the Swedish government on potential safety concerns.

## **5.5 Sustaining Safety Culture and Motivation**

In order to track any changes in safety culture and worker motivation at the decommissioning unit, Barsebäck conducted climate surveys. In addition, Barsebäck requested that WANO conduct a peer review and provide recommendations for improvements. SKI reviews the monthly reports regarding these efforts and discusses the issues that have emerged at monthly meetings as well as covering this area as part of its regular inspections.

## **5.6 Overseeing Contractor Work**

This has not been a significant issue at Barsebäck so far because there has not yet been a significant change in the use of contractors. SKI continues to monitor plans for future reliance on contractors and adequate contractor oversight.

## **5.7 Decommissioning at Multi-unit Sites**

SKI made a safety decision for all sites that dismantlement activity is not allowed until all units at a site are closed. Barsebäck has done a number of analyses with regard to this safety issue that have been evaluated by SKI. Barsebäck analyzed the use of unit 1 as a back up for unit 2. Barsebäck also identified the need for workers to give the same level of attention to the closed unit as to the operating unit. In order to assure that shift staff members were motivated and to improve integration of the work at the closed and operating unit, Barsebäck has integrated staffing of units 1 and 2. In this system the shift crew covers both units (1 operator per shift is assigned to unit 1 and operators rotate this assignment) and maintenance, quality assurance, and other service departments cover the needs of both units. SKI is monitoring the effectiveness of this strategy.

## **5.8 Delayed Dismantlement**

SKI made a safety decision that requires dismantlement when all units at a site are closed. Long term delay of dismantlement is not allowed.

## **5.9 Dealing with Emerging as Well as Known Safety Issues**

SKI and Barsebäck engage in a number of activities to assure that emerging safety issues are identified and addressed. These include:

- Monthly reporting to SKI on the status of the plant and decommissioning
- Employee climate surveys
- Co-ordination of plans and activities within SKI and between SKI and SSI
- Continued research on decommissioning experience by SKI
- Participation by SKI in international decommissioning forums

## **5.10 Determining and Communicating Level of Risk**

SKI and Barsebäck meet routinely on safety issues. One analysis done by Barsebäck was on the safety issues associated with partially used fuel. Because there were no initial plans for either use or storage of partially used fuel this was an emerging safety issue that needed to be addressed. The analysis evaluated both the potential use of partially used fuel in Unit 2 and the shipping and storage of partially used fuel off-site.

## 6. Comments and Conclusions

SKI was faced with both the immediate oversight of the first plant to decommission in Sweden and the development of a long-term strategy for regulating all phases of decommissioning nuclear power plants in the future. Simultaneously addressing both of these needs was challenging. However, there was a benefit that information gathered from research on decommissioning had direct application to oversight activities at Barsebäck and issues arising during decommissioning of Unit 1 of Barsebäck provided input regarding areas needing further research attention.

A number of organizational aspects the regulator needs to address in developing a long-term strategy were identified:

- Setting the appropriate priority for decommissioning oversight;
- Developing an organizational strategy for regulating decommissioning;
- Obtaining and developing necessary staff expertise for oversight of decommissioning;
- Determining and developing a regulatory framework for oversight of decommissioning.

Key organizational and human factors safety issues were determined. This list of safety issues suggests a scope for organizational and human factors evaluation of plants during decommissioning. Given the myriad of complex activities taking place, this focus is a useful way to assist the regulator to clearly articulate concerns to plants in terms of links to potential safety problems.

An initial discussion of how these safety issues are likely to emerge during different phases of decommissioning was presented. This is an area where further development would be useful.

Some key comments and conclusions from SKI's experience in regulating a decommissioning nuclear power plant include:

- Systematically gathering information on the experiences of others is extremely useful in responding effectively to regulation of a new phase of nuclear power plant activity.
- The political basis for the decision to shut down the plant early affected the safety issues that arose
- The long time period of uncertainty prior to the final decision to shut down the plant created safety concerns
- The regulator must focus and follow through on the implementation of plans by the plant
- Regulation of decommissioning took substantial time and resources—more than initially expected

# **Appendix A: Detailed Discussion of SKI Research Activities on Organizational and Human Factors Aspects of Decommissioning**

## **Activities during 1997**

In 1997 SKI commissioned a project to gather information on U.S. experience with decommissioning nuclear power plants. At that time 19 U.S. plants had begun the process of decommissioning and 3 reactors had been completely dismantled. The report from this project included information from a variety of sources, including interviews with U.S. Nuclear Regulatory Commission (NRC) management and staff, interviews and discussions with former employees of a decommissioned U.S. plant, discussions with subject matter experts, and relevant published documents. The final report from the project was titled: *U.S. Experience with Organizational Issues during Decommissioning* by Nancy Durbin and Rebekah Harty, January 1998. The report was published as a SKI Report 98:3. The major conclusions of the report were:

The NRC modified its rule regarding decommissioning requirements because 1) contrary to expectations, plants have been decommissioning early and for economic reasons instead of at the end of their license period and 2) a more efficient rule that would more effectively use NRC staff was desired.

The NRC management and staff expressed the opinion that resource requirements for the regulation of decommissioning were higher than required.

Key observations about decommissioning included:

1. The regulator faces new challenges to regulatory authority and performance during decommissioning.
2. The public concern over decommissioning activities can be very high.
3. There are changes in the types of safety concerns during decommissioning.
4. It is important to balance planning and the review of plans with verification of activities.
5. There are important changes in the organizational context at the plant during decommissioning.
6. Retention of key staff is important. In particular, the organizational memory about the plant that is in the staff should not be lost.
7. Six key areas of risk during the decommissioning process are fuel storage, potential accidents that could cause an offsite release (e.g., fire), inappropriate release of contaminated material, radiation protection of workers, industrial accidents, and shipment of hazardous materials.
8. Deconstruction of one unit while co-located unit is still operating would create risks with regard to shared systems, specific risks of dismantling activities (e.g.,

fire hazards) and coordination and management. Experience with co-located units at one site in the U.S. where one unit was operating while another was being decommissioned was that there was lack of attention to the decommissioning plant.

The overall conclusion of the report was that although there are many differences between the U.S. nuclear power industry and the Swedish nuclear power industry, the experiences of the U.S. with decommissioning provide useful ideas about potential problems that may arise in Sweden. In particular, organizational issues, such as psychological stress and uncertainty, which may arise while the plant is still operating but a decision has been made to permanently decommission, are important. In addition, the concerns about dismantling a unit while another is operating are particularly relevant to the Swedish case.

## Activities during 1998

In 1998 SKI completed four efforts in the area of organizational and human factors safety issues during decommissioning, 1) a report on the environment in Sweden for decommissioning, 2) two literature reviews, 3) an international workshop, and 4) work on the effects on uncertainty on workers during decommissioning.

A report, The Milieu for Decommissioning in Sweden (in Swedish, Inför kärnkraftsavveckling) SKI Report 98:13 by Lundqvist was completed. This report reviewed the findings on plant closings and downsizing in Swedish plants during the 1960's to the 1990's to identify potential safety concerns. It concludes that the period before and after the termination of power generation is connected with great strain. The vulnerability of the staff increases and the faith in management can easily be destroyed, which can affect safety and the decommissioning work. The feeling of security increases if the staff continuously is kept informed and within certain limits can influence the course of events. The report includes recommendations for maintaining the safety culture at the plant.

Literature reviews: 1998

- Barbara Melber *Articles on Organizational and Human Factors Issues in Decommissioning*. This review identified articles relevant to human factors and organizational issues in decommissioning nuclear power plants. The literature search results generally confirmed the lack of literature on organizational issues in contrast to the substantial and in-depth literature on technical issues of decommissioning. A few articles provided general information on decommissioning experience that may be useful. In particular, different utilities have used different organizational approaches to decommissioning such as using specialized decommissioning management contractors and specific employee retention programs. These may be useful in identifying specific utilities to contact for more in-depth study.
- Karin Lundqvist *Review of European Literature on Decommissioning* (in Swedish, *Kärnkraftsavveckling i Vasteuropa*) SKI Rapport 99:56. This report, which is a part of SKI's preparation for future Swedish decommissioning of nuclear power plants, gives an overview of the situation in Western Europe. Very few articles on organizational and human issues were found in sharp

contrast to in-depth literature on technical issues. A decommissioning wave can be expected after the year 2000. IAEA, OECD/NEA, and EU are working on harmonizing rules and preparing international guidelines. Decommissioning partly demands competencies other than technical operation. Key issues include management of change, responsibility when appointing contractors, keeping up work motivation and staff morale, retention of key competencies and transfer of “organizational memory”.

From May 11<sup>th</sup> to 13<sup>th</sup> of 1998 SKI held a workshop titled *Decommissioning and the Interaction of Man Technology and Organization* in Saltsjöbaden, Sweden. Representatives from SKI management and staff, SKB, SSI, the U.S. NRC, Britain’s NII, and other international experts and consultants participated. During the workshop small group meetings were held to develop ideas for future research on decommissioning which would focus on the interaction of man, technology and organization. There was a general agreement at the workshop that these areas had not been adequately addressed and that additional work was needed. Key areas of suggested future research included:

- Development of an overview of the organizational, technical, and regulatory processes for decommissioning
- Identification of safety vulnerabilities of specific organizational periods during decommissioning—focusing on pre-decision through permanent shutdown
- Determination of the lessons learned from strategies for management of change and methods to enhance safety culture used by plants during the decommissioning process
- Identification of advantages and disadvantages of alternative approaches to organizing decommissioning work at sites with both operating and shutdown units
- Determination of approaches for maintaining organizational memory during decommissioning
- Description of advantages and disadvantages of contractor use for major stages of decommissioning

In addition to topics of research, methods of research were noted. These included:

- Development of an initial description of organizational stages for decommissioning and the linkages between the organizational technical and regulatory processes based on current knowledge of plant decommissioning, industrial closures in general, and management of change
- Empirical study of the actual process experienced by plants, based on selecting a sample of plants from other countries, in the U.S. and Europe, that are in the process of decommissioning
- A prospective study of decommissioning in Sweden, beginning with gathering baseline information during the operational phase at selected Swedish plants.

Also in 1998, SKI sponsored an evaluation of the potential effects of the uncertainty created by discussions of decommissioning a plant on the workers at that plant. A paper discussing this issue was prepared and was presented at the Safety System Society meetings in September 1998 in Seattle, Washington, USA. The paper was titled *Potential Effects of Organizational Uncertainty on Safety* by Nancy Durbin, Anna

Lekberg, and Barbara Melber. This paper reported that when organizations experience significant change—reorganization, mergers, acquisitions, decommissioning, or downsizing—the workers in those organizations experience significant uncertainty about the future. This uncertainty can adversely affect morale, can reduce concentration on safe operations, and can result in the loss of staff having key competencies to maintain safe operations. Hence, safety sensitive organizations contemplating significant change need to consider and plan for the effects of uncertainty on safety—as well as planning for other consequences of the change. This paper discusses what is known about the effects of uncertainty on individuals and discusses the potential consequences of this type of uncertainty on worker behavior in safety sensitive organizations.

## Activities during 1999

In 1999 SKI was an active participant in the CSNI Workshop: *Nuclear Power Plant Transition from Operation into Decommissioning: Human Factors and Organizational Considerations* held in Rome Italy, May 17-18, 1999 and sponsored two research efforts.

The first research effort resulted in a paper that was presented at the CSNI workshop in Rome, *Decommissioning as an Organizational Process* by Karin Lundquist. This paper examines the lessons learned from downsizing of Swedish organizations outside of the nuclear field. Key lessons learned include that the staff will feel more secure if there is openness and some influence on the direction being taken, that both the staff and the organization need to adopt a new orientation as quickly as possible, that lack of motivation among workers has been found to create problems during decommissioning, and that flexibility and the willingness to re-examine plans is also important during decommissioning.

The second research effort also resulted in a paper, *Regulatory, Organizational and Technical Processes of Decommissioning*, by Barbara Melber and Nancy Durbin, which was presented at the CSNI workshop in Rome. In this paper the authors stressed the importance of looking at a whole systems view of decommissioning—including organizational and regulatory processes. To better demonstrate the importance of this view, the paper uses work process modeling tools to diagram various levels and stages of decommissioning. While the diagrams presented in the paper are somewhat hypothetical, they provide a first step in better understanding the overall process of decommissioning.

In addition to sponsoring two of the papers at the workshop, SKI played a major role in the organization and implementation of an international workshop devoted to the development of knowledge about the human factors and organizational safety during decommissioning. Participants from Finland, France, Germany, Italy, Japan, Korea, the Netherlands, Sweden, the United Kingdom, and the United States attended. Further more, representatives from OECD Nuclear Energy Agency were active at the workshop. The manager of SKI's MTO group, Gerd Svensson, chaired the meeting and was responsible for drafting the final report from the workshop: *Draft Report on the CSNI Workshop: Nuclear Power Plant Transition from Operation into Decommissioning: Human Factors and Organizational Considerations*. As a final output she also presented

the main results of the workshop at the joint NEA/IAEA/EC workshop: *Regulatory Aspects of Decommissioning*, Rome Italy, 19-21 May 1999.

- Papers prepared for the OECD/NEA Workshop Meeting on the Nuclear Power Plant Transition from Organizational and Human Factors Considerations. May 17-18, 1999 included:
  - Karin Lundquist, Decommissioning as an Organizational Process
  - Alan Ellis Trawsfynydd Power Station—The Transitions from Operations to Defuelling and Defuelling to Decommissioning
  - Barbara Melber and Nancy Durbin, Regulatory, Organization and Technical Processes of Decommissioning
  - Felicity; Harrison (AECB, Canada) The Management of Contractors During Decommissioning Activities in Nuclear Facilities
  - M.J.J.M. Ruesen (N.V. GKN, the Netherlands) Dodewaard Transition from Operation into Decommissioning
  - Craig Reiersen, (H.M. Principal Inspector, Nuclear Installations Inspectorate) Regulating Organizational change on Nuclear Licensed Sites and at Corporate Headquarters.

## **Activities during 2000**

In 2000 SKI supported work on diagramming decommissioning processes in order to improve understanding of how safety issues (identified during earlier activities) might emerge over the course of decommissioning. Meetings on diagramming decommissioning processes were held in Stockholm in May of 2000.

## Activities during 2001

There were three main activities, in addition to preparing this report, in 2001. One was a draft letter report summarizing organizational and human factors safety issues during decommissioning and suggesting a regulatory approach for decommissioning titled *Decommissioning Nuclear Power Plants: Identifying and Addressing Safety and Regulatory Issues*: by Nancy E. Durbin and Barbara Melber. The second was an interpretation of the application of and SKI Regulation (SKIFS 1998:1), to decommissioning and the third was beginning the development of a guidance document for SKI decommissioning activities.

In the letter report some of the major elements of key organizational and human factors safety issues that arise during decommissioning were identified and summarized. The organizational issues that a regulator faces when developing a way to regulate a new phase of the life cycle of nuclear power plants, decommissioning are also briefly described. These include:

- Setting the appropriate priority for decommissioning oversight;
- Establishing an organizational strategy for regulating decommissioning;
- Obtaining and developing necessary staff expertise for oversight;
- Developing a regulatory framework for oversight of decommissioning.

Three components of a potential regulatory framework were presented:

- Reviewing existing law and regulations;
- Gathering and evaluating information and experience regarding decommissioning;
- Developing a strategy for oversight of safety during decommissioning.

Finally, a suggested approach to developing a strategy for regulatory oversight was presented. This approach included:

- Identifying key activities that cover a licensee's major responsibilities for decommissioning;
- Identifying the key organizational and human factors safety issues that are relevant for the major activities;
- Evaluating whether and how the licensee has addressed the relevant safety issues as they carry out the major decommissioning activities.

The evaluation of a SKI Regulation (SKIFS 1998:1) with regard to decommissioning provided a review of the regulation by outside experts with regard to its application to decommissioning. The expert review did not represent the SKI or Swedish legal view of the regulation but provided something for SKI staff to respond to with regard to the interpretation of the regulation. A letter report, *Implications of the General Regulation (SKIFS) for Decommissioning by Melber and Durbin*, was prepared.

Recommendations for a guidance document for decommissioning were developed based on interviews with SKI staff involved with decommissioning. These recommendations along with a draft outline for a decommissioning guidance document were documented in a letter report.