SKI Report 98:3

U.S. Experience with Organizational Issues During Decommissioning

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Summary

Background

The purpose of this report is to provide information about U.S. experience with decommissioning that will be useful to SKI's further development of a regulatory approach to decommissioning.

Implementation

The report provides 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 report is therefore based on experiences and expert opinion rather than a formal scientific study. Further study to determine whether these findings can be applied to other cases may be needed.

Five stages of decommissioning were considered as part of the study. These were:

- Pre-decision
- Post-decision
- Deactivation and defueling
- Potential storage period
- Deconstruction and dismantlement.

Results

The NRC has modified its rule regarding decommissioning requirements. Two key reasons for these modications are that first, contrary to expectations, plants have been decommissioning early and for economic reasons instead of at the end of their license period and, second, a desire for 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 regulatory have been higher than anticipated.

Key observations about decommissioning of U.S. nuclear power plans included that:

- The regulator faces new challenges to regulatory authority and performance during decommissioning.

- The public concern over decommissioning activities can be very high.

- There are changes in the types of safety concerns during decommissioning.

- It is important to balance planning and the review of plans with verification of activities.

- There are important changes in the organizational context at the plant during decommissioning.

- Retention of key staff is important. In particular, the organizational memory about the plant that is in the staff should not be lost.

- 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.

- Deconstruction of one unit while a co-located unit is still operating could 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 a lack of attention to the decommissioning plant.

Key findings regarding each of the five stages were:

- **Pre-decision.** In the pre-decision stage the plant is operating under normal conditions. If there is a rumor or serious discussion of decommissioning then organizational issues such as staff retention may emerge.

- **Post-decision.** During the stage after a decision has been made to shutdown and decommission the plant, and before deactivation and dismantlement, organizational issues are particularly important. In this stage the plant is operating but the organizational context is very different than in the plant prior to the decision. Staff may have left, morale is low, and the plant is focused on planning for decommissioning as well as operating.

- **Deactivation and defueling.** The deactivation and defueling stage includes critical activities that rely on the planning and preparation done during the earlier stages for success. Once these activities are completed the possibility of a catastrophic accident is reduced.

- **Potential storage period.** After the deactivation and defueling stage many plants in the U.S. have gone into a storage stage prior to dismantlement. Organizational issues during this stage include maintaining sufficient organizational oversight of the site.

- **Deconstruction and dismantlement.** During the final deconstruction and

dismantlement stage the main organizational issues are that loss of staff with nuclear experience and use of contractors may reduce the organizational safety culture at the plant. Also, maintaining control of contaminated waste is critical during the final stage.

Conclusions

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, that 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 unit is in operation are particularly relevant to the Swedish case.

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1 Introduction

1.1 Background

While many of the technical aspects of decommissioning and deconstructing a nuclear power plant have been addressed, less attention has been paid to the human and organizational factors. In order to increase its knowledge base and enhance its ability to deal with the organizational and human factors aspects of nuclear power plant decommissioning, SKI commissioned a study to provide information about the U.S. experience with decommissioning nuclear power plants in order to identify social (human) and organizational issues that may affect safety during nuclear power plant decommissioning. A team from Chockie Group International, MPD Consulting, and Battelle were selected for this effort because of their expertise about decommissioning of nuclear power plants in the U.S.

1.2 Objective

The purpose of this report is to provide information about U.S. experience that will be useful to SKI's further development of a regulatory approach to decommissioning. This report provides a summary of U.S. experience with and lessons learned about the organizational issues that arise during decommissioning.

1.3 Approach

The approach to the effort was to produce a summary of information on decommissioning experiences obtained from a variety of sources. The intent was not to produce a formal scientific study (which would be beyond the scope of the assignment), but rather to provide a broad range of experiences, expert opinions, and information on the subject. Further study to determine whether the information recorded in this report can be generalized to other cases may be necessary. This approach was designed to inform SKI management and staff of potential issues to consider as they plan for decommissioning activities in Sweden.

Key general observations about U.S. experience with the decommissioning process from a regulatory perspective were identified from interviews with U.S. Nuclear Regulatory Commission (NRC) staff involved in oversight of decommissioning of U.S. power plants. Additional information was obtained from relevant documents and from interviews with subject matter experts, including former staff from a decommissioned U.S. nuclear power plant.

1.4 Method

Information for this report was obtained from published NRC documents and other relevant published sources, interviews with NRC management and staff, interviews and group discussions with subject matter experts at Pacific Northwest National Laboratory (PNNL), and interviews and group discussions with former employees of a nuclear power plant in the process of decommissioning. The following questions were addressed in the interviews:

1) What are the main similarities and differences in operating plants and decommissioning plants in terms of management, training and competence, and documentation?

2) What are the characteristics of a plant prior to shut down that are important to determining the potential success of the decommissioning effort?

3) How do you work with plants that are decommissioning? What do you look for? How do you document your findings? (NRC interviews only.)

4) What are the critical issues to consider when shutting down a dual unit compared to a single unit facility (including if one unit is being shut down while the other unit continues operating)?

The group discussions provided both independent input to the report and validation of findings from earlier interviews and document reviews. The discussions began with an overview of the regulatory outcomes and the issues arising during each stage which had been identified from previous interviews and from the review of documents.

1.5 Report Organization

After this introductory Section, Section 2 of this report provides an overview of the U.S. Nuclear Regulatory (NRC) regulatory approach to and experience with decommissioning. Section 3 provides a breakdown of decommissioning into five stages and discusses the experience and lessons learned about each stage of decommissioning. Conclusions are presented in Section 4. Excerpts from the U.S. Federal Register Notice (60 FR 37374-37388), which describe the reasons the NRC modified its regulation on decommissioning are provided in Attachment 1.

2 NRC Regulatory Experience

2.1 Regulatory History

The NRC defines decommissioning as follows: "Decommissioning means permanently removing a nuclear facility from service and reducing radioactive material on the licensed site to levels that would permit termination of the operating license granted to the utility by the NRC."

The NRC published and adopted a rule on decommissioning on June 27, 1988 (53 FR 24018). A revised rule was published for comment on July 20, 1995 (60 FR 37374); it was further revised following the comment period and the NRC published the final version of the rule on July 29, 1996 (61 FR 39278-39304). This section briefly describes the major differences between these two rules.

The 1988 rule was based on certain assumptions that led to requirements for plant decommissioning. First, it was assumed that plants would be decommissioned after the facility's operating license expired (nuclear power plants in the U.S. are commonly licensed for a 40 year period). Second, since the date of shutdown and decommissioning would be anticipated, it was assumed that there would be a significant period of time (five or more years) prior to decommissioning to plan for the decommissioning activities. Therefore, the rule required that a preliminary decommissioning plan be submitted five years before the operating license expired. The regulations also required that no later than one year before expiration of the operating license (or within two years of permanent cessation of operation for plants that closed before their license expired) that an application for authority to decommission the facility be submitted. The application was to be accompanied by or preceded by a proposed decommissioning plan. The rule required that this plan include, among other things, a description of:

. all activities from the start to the end of decommissioning
. the controls and limits on procedures and equipment to protect occupational and public health and safety
. the final radiation survey
. an updated estimate of the cost of decommissioning
. technical specifications and quality assurance provisions.

The underlying assumptions of the NRC's 1988 rule have parallels to the Swedish case. Expectations about the nature of decommissioning in Sweden are described in the SKB Technical Report 94-20, *Technology and costs for decommissioning of Swedish nuclear power plants*, June, 1994. (Relevant paragraphs are provided in Table 1.) As with the NRC, there is an assumption of a long period for planning prior to decommissioning. In addition, it is expected that there will be a 5-year period in which to create an inventory of needs for special equipment for dismantling work.

Table 1. SKB Report Discussion of Steps and Principles of Decommissioning Planning

Planning and execution of decommissioning of the Swedish nuclear power plants is planned to follow the steps and principles described below. This does not include the preliminary work in the form of R&D activities and other work that has already been done and is being done by SKB within the decommissioning field.

- *Creation of a specific project group charged with the task of preparing for and planning the decommissioning. This is done 3-4 years before production operation of the nuclear power unit ceases. The project organization then exists and operates until the entire work of decommissioning is concluded and restoration of the nuclear power plant site has been carried out. The time from the termination of electricity generation until completed restoration is estimated to be about 7 years for the first unit on a site.*
- *Shutdown operation starts on termination of power generation and lasts until dismantlement of the unit has begun. During this time all fissile material (fuel) is removed from the plant and preparations are made for dismantling, e.g., decontamination. The workforce is reduced gradually during this period.*
- *Service operation starts when the dismantling work begins and is maintained by a reduced operating organization.*
- *Dismantlement of systems, demolition of buildings and site restoration.*

An overhaul of SKB's transportation system, which is designed today for operational waste, must be done to adapt it to the decommissioning waste. The decommissioning waste differs to some extent in character but mainly in its large quantity from the operational waste. It is estimated that the work of overhauling the transportation system will take five years and that a report on the results will be submitted about 2-3 years before final shutdown. The report will also contain a proposal for supplementary equipment, e.g., site-specific equipment, equipment for sea transportation, equipment in the final repository and transport containers.

An inventory of the need for special equipment for the dismantling work is projected to begin about 5 years before final shutdown and to proceed with varying intensity until the dismantling work begins. The objective is that dismantlement shall be carried out with known and proven technology. However, some equipment must be tailor-made for its special applications and be adapted to station-specific needs.

Source: SKB Technical Report 94-20. 1994. *Technology and Costs for the Decommissioning of Swedish Nuclear Power Plants.* Swedish Nuclear Fuel and Waste Management Company, June.

Actual decommissioning in the U.S. has been different, in large part because the reasons for decommissioning have tended to be economic ones. Currently 19 plants have initiated the decommissioning process (see Table 2). All plants entering the decommissioning process after 1988 were shutdown before the expiration of their license without having submitted the documentation required under the 1988 regulations. The utilities wanted to cease operations and begin decommissioning as quickly as possible. However, according to the regulations, licensee's could not initiate the decommissioning process until the lengthy decommissioning plan was developed and the review process completed. Prior to the current rule, some licensee's started the decommissioning process (such as removing large components or performing initial decontamination) while preparing the decommissioning plans. However,

these actions were later ruled to have been inappropriate under the regulations existing at that time.

Table 2. U.S. Plant Decommissioning Activities

Number of plants in the decommissioning process as of September 1997: 19

- 3 power reactors completely dismantled (Pathfinder, Shoreham, and Fort St. Vrain)
- 2 power reactors now being dismantled (Trojan and Yankee Rowe)
- 3 power reactors planning immediate dismantlement (Big Rock Point, Haddam Neck, and Maine Yankee)
- 11 power reactors in or planning long term storage (CVTR, Dresden 1, Fermi 1, GE VBWR, Humboldt Bay 3, La Crosse, Peach Bottom 1, Rancho Seco, San Onofre 1, Saxton, and Indian Point 1)

Experience with decommissioning reactors such as Dresden 1, Trojan and Yankee Rowe indicated that regulator review and approval of detailed plans for routine decommissioning activities was neither necessary, or necessarily desirable. New and unanticipated issues arose during the decommissioning process. This meant that the decommissioning plan no longer fully applied and revisions had to be made and subsequently reviewed by the NRC. Changes to the plans were required as a result of organizational changes by the utility, new technology, or new information. Additionally, during decommissioning at the Dresden 1 plant (a nuclear power plant operated by Commonwealth Edison Company in Northern Illinois), it was determined that some of the assumptions made in the decommissioning plan were not accurate.[1]

The NRC staff recognized that the majority of activities that are engaged in during decommissioning were no more complicated than activities normally undertaken at operating reactors without prior and specific NRC approval. Once the plant is defueled, the main safety issues are safe storage of fuel and the protection of the workers and environment. These issues are also important at operating plants. Hence, it was determined that the activities occurring during decommissioning could be covered by the regulations used during operations, which allow licensees to make non-safety significant changes without prior approval by the NRC.[2] In

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One of the assumptions of the decommissioning plan was that the containment heating and ventilation systems at the Dresden 1 plant would remain operational. However, they were not kept operational and as a result the service water system inside containment ruptured due to freeze damage. This released approximately 55,000 gallons of water into the basement of the unheated building. A subsequent investigation identified that there had also been a potential for a freeze damage failure of the fuel transfer system located in containment, which would have resulted in partially draining the spent fuel pool.

The regulations (10 CFR 50.59) allow licensees to make specific types of changes to the plant without prior NRC approval unless the proposed change involves the modification of the technical specifications that are incorporated into the license or if it involves a safety question that has not previously been reviewed. The types of changes include 1) changes in the facility as described in the safety analysis report; 2) changes in the procedures described in the safety analysis report; or 3) conduct tests or experiments not described in the safety analysis report.

addition to these safety issues, the regulatory issues of concern include assurance that plants maintain the financial ability to fully fund decommissioning and that the radioactivity on the site will be returned to levels that would permit termination of the operating license.

In response to the need for a more streamlined approach to decommissioning that combined safety issues and the appropriate level of oversight, the NRC revised the 1988 rule in 1996. Changes included:

- Decommissioning activities are divided into three phases 1) the decision to cease operations, 2) storage, 3) termination of license.

- The licensee initially submits a certification stating that power operations have or will cease on a specific date. The licensee also submits a certification after the fuel has been permanently removed from the reactor vessel. This provides regulatory relief from requirements for systems and procedures that are no longer necessary.

- There is no longer a requirement for submittal or subsequent NRC review of a detailed decommissioning plan prior to decommissioning. Instead, a Post-Shutdown Decommissioning Activities Report (PSDAR) is required, which contains a general plan of future activities and a schedule, as well as some environmental and financial status information.

- Major decommissioning activities can be carried out after the NRC receives certification that the fuel has been removed and 90 days after receipt of the PSDAR.

- The licensee must not perform any decommissioning activity that 1) forecloses release of the site for possible unrestricted use, 2) causes any significant environmental impact not previously reviewed or, 3) results in there no longer being reasonable assurance that adequate funds will be available for decommissioning.

These changes and the NRC's rationale for these changes are described in the proposed rulemaking published in the Federal Register in July of 1995. (See Attachment A for the relevant discussion of the reasons for the rule changes and a description of the rule changes that was provided in July 1995 Federal Register.)

Currently, most plants continue to write a detailed decommissioning plan similar to that required by the 1988 rule. However, the NRC receives only the brief PSDAR and checks only to see that the licensee has included the required information. The intent of the revised rule is to allow licensees to decommission more quickly and efficiently, to reduce costs, and to provide for more effective use of NRC staff.

The NRC reviews the basis for an the analysis of the safety significance of each change.

2.2 NRC Experience—Resource Requirements and Key Observations

2.2.1 Resource requirements for the regulator

The NRC management and staff expressed the opinion that there was an underestimation of the resources that would be required by the NRC to regulate plants during decommissioning. The general expectation had been that the reduction in safety risk after the removal of fuel would significantly reduce the need for regulatory oversight. Instead, during the first year of decommissioning, the need for oversight and attention appears to be more than at an operating plant. Then, during the initial shut down and planning period for decommissioning, the level of effort required by the regulator has been similar to an operating plant. After these initial periods, the demands on the regulator have decreased.

Six reasons for the increase in regulatory resource demands were mentioned in interviews or ascertained from documents:

1) The public becomes very involved with, aware of, and concerned about public safety, the environment, and community impacts during decommissioning. In particular, the public is concerned that the regulator will cease its oversight of the plant prior to the resolution of all safety and environmental issues. This requires attention and response by NRC staff.[3]

2) Technical problems that have not been previously addressed arise. These problems require basic engineering and research by NRC to evaluate the approach being used by the licensee. For example, one facility is considering shipping the pressure vessel with the reactor internals intact. This would, they believed, reduce risk both to workers and to the public. The NRC needed to evaluate this approach.

3) Problems that may have existed or been created during operation come to light and create public and regulatory concern during decommissioning. For example, at one site it was discovered that soil previously removed from the site was contaminated with radiation. The soil had been used in various public spaces, including a children's play ground. This required a response by the NRC.

4) New techniques and standards are applied to activities or verifications carried out in the past. For example, in the example discussed above (#4), the level of soil contamination was lower than could be identified by the technology available when it was released. A re-check of the soil with newer equipment identified the contamination.

The current regulations include requirements to hold public meetings. The NRC staff mentioned that enlisting a local governing official to chair and facilitate the public meeting is very effective. The local official sets the agenda and the tone for the meeting. The licensee and NRC staff members provide information, take comments, and answer questions during this public meeting.

5) Identification of redundancies and gaps in regulatory authority over certain decommissioning activities requires attention. For example, within the NRC, two offices; the Office of Nuclear Reactor Regulation (NRR), and the Office of Nuclear Materials Safety and Safeguards (NMSS), created a memorandum of understanding to address overlaps in responsibility. In addition, the NRC continues discussions with the U.S. Environmental Protection Agency regarding appropriate requirements for final site release.

6) The assumptions and the completion of the activities in the decommissioning plan (now the PSDAR) must be verified. At one site, although the plan stated that there would be a dedicated manager for the decommissioned unit, none was assigned.

2.2.2 Key observations by NRC management and staff

NRC management and staff provided a great many observations regarding the decommissioning process. Many of these are provided in the discussions of issues that arise during each stage of decommissioning, discussed in Section 3. General observations that apply to the entire process are provided below.

2.2.2.1 Challenges to regulatory authority and performance

The regulator is faced with certain challenges. Once the plant is shut down, the regulator loses the part of its power and influence that is based on its ability to shut the plant down. Also, during decommissioning the NRC reduces its presence at the plant and relies more on the licensee to provide information. There is, therefore, a greater opportunity to miss critical changes.

2.2.2.2 Public concerns

The regulator needs to recognize public concern issues—both continued regulatory assurance of safety for the general public and the socio-economic concerns of the people who are affected by the shutdown. The public needs assurance that the regulatory body is still maintaining its role during decommissioning.

2.2.2.3 Changes in safety concerns

During operations, the concern is about risk (e.g., radiation release) to offsite populations; during decommissioning (after defueling) the risk is greater for on-site staff (e.g., industrial accidents, radiation exposure). While the possibility of an accident causing exposure of the offsite population is greater during operations than during decommissioning, the possibility of an injury or worker exposure accident may be greater during decommissioning.

2.2.2.4 Balancing planning and verification

One overall observation which applies to all regulation was made in reference to experiences with decommissioning: "Trust but verify." Some NRC staff expressed the opinion that the

1988 decommissioning regulation encouraged an over reliance on reviewing plans rather than verifying performance.

2.2.2.5 Changes in organizational context

The organization (running the plant) changes dramatically at the decision to shut down and again at shutdown. The plant loses its mission. There is a loss of staff, and general depression and denial that the plant is really going to shutdown. Some NRC staff expressed the opinion that it takes 6 months to a year to re-establish momentum and start the decommissioning. Once the plant loses its mission (i.e., to produce power) it may be harder to maintain a strong safety culture at the plant. People may be less likely to follow safety procedures and may not keep records up to date. Management actions and the staff's level of trust in management are very important during this period.

2.2.2.6 Retaining organizational memory

It is important for the licensee to retain the organizational memory of the plant needed for decommissioning activities. No matter how good the drawings and documents, there is a critical organizational memory lodged in the staff that must be documented before they leave.

2.2.2.7 Key areas of risk during decommissioning

NRC staff and others mentioned six key areas of risk that require attention during decommissioning: 1) fuel storage, 2) any potential accidents at the plant that could cause an off-site release (e.g., fire), 3) inappropriate release of contaminated material, 4) radiation protection of workers, 5) industrial accidents, and 6) shipment of hazardous materials.

2.2.2.8 Decommissioning co-located units

There were several observations regarding regulation of two co-located units where one continues to operate and the other is decommissioned. First, there was a general consensus among those interviewed that doing deconstruction next to an operating plant would create some difficulties related to 1) shared systems, 2) specific risks of dismantling activities (e.g., fire hazards), and 3) coordination and management. Dismantling dual units at the same time was seen as creating fewer problems. Second, decommissioning one unit while operating a co-located unit resulted in inattention to the decommissioning unit activities at at least one U.S. plant. Despite this difficulty, the existence of a co-located operating unit was seen as improving the availability of resources and the continuation of a safety culture at the decommissioning plant. Other observations about operating one unit co-located with a decommissioning unit were that plants experienced problems with lack of communication, poor QA at the decommissioning plant, and incomplete audits (audits which were supposed to cover the whole site were only done at the operating unit).

3 Lessons Learned about the Organizational Issues During Decommissioning Stages

3.1 Stages of Decommissioning

Five stages of decommissioning were identified as useful categories for discussion. These categories of stages were developed and are used for heuristic purposes and are not based on any research or validation. The stages used are:

1) Pre-decision. During this stage the plant remains in operation and the public safety risk from operating the reactor continues. There may be a rumor or serious discussion about near-term permanent shutdown.

2) Post-Shutdown Decision. During this stage the plant remains in operation and the public safety risk from the fuel continues. A decision to permanently shutdown the plant has been made and publicly announced. A date for termination is set and the plant creates a detailed plan for decommissioning.

3) Deactivation and Defueling. During this stage the plant shuts down operations and the reactor is defueled. The public safety risk of a catastrophic accident is essentially eliminated. Risks from radioactive materials and waste, including worker exposure risk continues. Many of the safety systems and operations systems at the plant are no longer necessary.

4) Potential Storage Period. During the period the plant is defueled and the fuel may be stored on site (e.g., in the spent fuel pool) or off site. This strategy is used when deconstruction and decontamination of the site are delayed for some reason (e.g., another unit is still in operation at the site or facilities for permanent fuel storage are not available).

5) Deconstruction and Dismantlement. During this stage there is a complete deactivation and removal of equipment and systems. The site is returned to restricted or unrestricted use.

3.2 Issues During Each Stage

In this section issues that were mentioned as particularly important during each stage of decommissioning are discussed.

3.2.1 Pre-decision period

Because all currently operating plants are going to decommission at some time, even plants that anticipate operating until license completion (with or without a license renewal period) are at the pre-decision stage. During the pre-decision stage the plant is operational and the potential for a catastrophic accident exists. The regulator is primarily concerned with

operational safety and the regulatory issue with regard to decommissioning is assuring that plants are maintaining some general preparation; for example, the accumulation of decommissioning funding. Other issues regarding decommissioning are not particularly relevant unless the plant is facing rumors or discussions of near-term permanent shutdown. These plants face a number of issues of concern to the regulator. These include the consequences of uncertainty such as apathy, stress, lack of commitment to the future (Blalock & Wilkin, 1979), a tendency to put projects on hold "until decisions are made", the possible deterioration of the organizational safety culture, and the loss of key personnel. U.S. plants experienced major losses of key personnel prior to the final decision to decommission.

3.2.2 Post-decision still operating

During this period the regulator is still primarily concerned with operational safety, but must also attend to the licensee's planning and preparation for decommissioning.

Although operations continue during this period, the organizational context within which the plant operates may change dramatically and is particularly important. The period was described by interviewees as "a mourning period," "like a death" "the whole place seems to be in a severe depression". When the plant loses its mission, the workers lose their life's work. Hence, the safety culture may decline and the momentum may change. One interviewee from the industry noted that after the permanent shut-down decision there was a perception among the workers that there was no hurry to complete anything, including corrective actions. NRC staff noted that the plant's management approach and the level of trust the staff has in management is very important at this stage. Staffing issues need particular attention during this period as there is a significant risk of losing important staff and organizational memory while the plant is still operating. Because much of the organizational memory resides in the staff, and knowledge of the plant is critical in successful decommissioning, management attention to retention of key competencies is critical during this stage. Critical areas mentioned included training, management of systems and functions (e.g., fluid and effluent systems) and those with familiarity with the safety evaluations. Operators in decommissioning U.S. plants may rotate with spent fuel handlers as long as they continue to be trained in both areas. If there is another unit that will still be operating, the focus seems to shift to the operating unit and away from the unit that is to be decommissioned.

Findings from an NRC sponsored study on staffing found that one key issue associated with the plant's readiness to initiate decommissioning was the duration of a temporary shutdown prior to the decision and advance planning before the shutdown decision (Baker, K. et al, 1996).

NRC staff mentioned the importance of having a good understanding for the reasons and the basis for any design changes in the facility and that a good design basis should be established prior to decommissioning. This prevents surprises and informs the regulator about potential problems that may arise.

In terms of overseeing decommissioning planning activities, four key areas of concern were mentioned by NRC staff as critical: 1) any potential for release of contaminated materials, 2)

safety of the spent fuel pool (e.g., siphoning of spent fuel pool, seismic qualifications of the spent fuel pool, etc.) 3) industrial safety during dismantling, 4) anything that creates an offsite dose potential.

A specific area addressed in the interviews with regard to planning activities was documentation. Respondents noted that a documented site survey regarding contamination would be important because, for example, some spills may not have been documented. Establishing what radioactive material has been disposed of on site is fundamental to clean-up activities. This could be done with an examination of radioactivity and with a survey of past and present employees for history of any contamination (e.g., pipe leaks, chemistry laboratories, undocumented releases). Other documentation mentioned as being of interest prior to decommissioning included the spent fuel pool design basis, an exact inventory of all spent fuel assembly and other radioactive waste (including the number of curies and location) and a record of any foreign material in the spent fuel pool. NRC staff mentioned that the longer the storage, the more important the documentation because the knowledge of the plant staff will be gone. Also, documentation of electrical systems, pumps, water levels, temperature, and chemical monitoring were mentioned as important. The planning activities must include attention to the availability of resources—including waste storage and transportation—and the competition for those resources during the time period of decommissioning. Finally, the planning must account for the assurance of safety at any co-located unit during decommissioning of the affected unit.

3.2.3 Deactivation and defueling

Deactivation and defueling activities represent a crucial dividing point within the decommissioning process. The success of these activities is tied to the effectiveness of the planning, staff retention, and documentation efforts in the previous stage. Once deactivation and defueling are complete, a significant number of procedures required for operations are no longer needed and there is a substantial decrease in the risk to the public. The risk now shifts to personnel working at the site—in the form of industrial type accidents during heavy construction activities—and contamination risks from materials being handled, transported, and stored. In addition, the spent fuel pool remains as a risk until fuel is removed from the pool and put into either dry storage or a federal repository. The organizational context changes dramatically during this stage. There is a precipitous decline in the required personnel for day to day activities, and an increased demand for workers during specific activities. This is often accommodated by the use of contractors. The use of contractors for major activities (with the concomitant issue that few employees may be overseeing many contractors) may create a loss of safety focus because personnel not familiar with the nuclear environment may be responsible for maintaining safety of nuclear materials and waste. It may be difficult to maintain adequate staffing to oversee site management and contractor management and to respond to unanticipated problems. The competencies needed during this period switch from operating and maintenance to certified fuel handlers, radiation protection, and health physics.

3.2.4 Potential temporary storage period

In some cases units will be in storage for a period which may be from very short to very long. There may not be a rush to find decommissioning and deconstruction because other units at the site are also going to shut down or because long term fuel or waste storage is not available. The potential risks from long term on-site storage arise from the possibility of a lack of attention to the site, a lack of permanent dedicated staff, and loss of organizational memory. U.S. experiences indicates that decommissioning sites need a dedicated staff and "ownership" of the unit. If there are no operating plants at the site, support for the site may be minimal. The spent fuel pool continues to need monitoring (if spent fuel is present), and although there is no real activity, there may still be radioactive materials on site. Interviewees focused primarily on the experience at Dresden 1 for examples of problems in this stage. One problem that occurred at Dresden 1 was that they were not appropriately posting and locking out areas during maintenance activities. The performance at Dresden 1 has improved since ownership by a dedicated staff was established. In general, interviewees expressed the opinion that if there is another operating reactor at the site it both increased safety because the organizational culture is still strong, and facilities and staff were still available, and decreased safety because attention was focused on the operating unit.

3.2.5 Dismantlement

The major activities during this period are construction type activities, but with an important difference. Unlike constructing a nuclear power plant, when deconstruction occurs the facility contains significant radioactive material. The protection of workers handling the materials (in addition to normal safety issues surrounding heavy construction type activities), the assurance that all contaminated materials are safely and completely removed from the site, and assurance of safe transportation and storage of radioactive materials are the key issues. Because the primary systems are badly contaminated it is a difficult and expensive job to deconstruct the plant. In terms of organizational issues, the experience of the management and supervisory personnel with radiation protection will need to be assured since workers during this stage may not be familiar with nuclear safety issues or have a nuclear safety culture. The other issue that has been a problem in the U.S. experience has been the inappropriate release of low level radioactive waste.

Logistics become especially important at this stage. There is a lot of low level waste that needs shipping. If the infrastructure for shipping is inadequate, it may lead to a backlog. This occurred at Three Mile Island, Unit 2 during the post-accident clean up period. Low level waste was stored in the containment area and in a way that created a potential for a fire loading problem. This occurred because they didn’t keep up with shipping. Review of shipping plans is needed to assure on site storage doesn't become an issue.

With regard to dual units, NRC staff suggested that it would be better if deconstruction were done all at once due to hazards, noise, dirt, etc. associated with dismantlement. There was a general consensus among NRC staff that dismantling one unit next to an operating unit could

create unnecessary risks, and that utilities with dual units would be better off if the units were dismantled at the same time.

4 Conclusion

Although there are many differences between the nuclear industry in the United States and the nuclear industry in Sweden, the experience of the U.S. with organizational issues during decommissioning has relevance for SKI's further development of a regulatory approach to decommissioning. In particular, organizational issues, such as psychological stress and uncertainty, that 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 unit is in operation are particularly relevant to the Swedish case. Other useful findings are the U.S. experience with more than regulatory resource requirements for the regulator and observations regarding areas of risk during decommissioning. This report represents the opinions of individuals who have experience with decommissioning in the U.S. Further research would be required to verify whether the findings in this report can be applied in other cases.

References

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Attachment I

Excerpt from the U.S.Federal Register (60 FR 37374-37388), Nuclear Regulatory Commission: "Decommissioning of Nuclear Power Reactors"

[Federal Register: July 20, 1995 (Volume 60, Number 139)]
[Proposed Rules]
[Page 37374-37388]
From the Federal Register Online via GPO Access [wais.access.gpo.gov]
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NUCLEAR REGULATORY COMMISSION

10 CFR Parts 2, 50, and 51

RIN 3150-AE96

Decommissioning of Nuclear Power Reactors

AGENCY: Nuclear Regulatory Commission.

ACTION: Proposed rule.

When the decommissioning regulations were published and adopted on June 27, 1988 (53 FR 24018), it was assumed that the majority of nuclear power reactor licensees would decommission at the end of the operating license. Since that time a number of licensees have shut down prematurely without previously having submitted a decommissioning plan. In addition, these licensees have requested exemptions from certain operating requirements because, without fuel present in the reactor, they are no longer needed. Each of these cases has been handled individually without clearly defined generic requirements.

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The Commission is proposing to amend the decommissioning regulations in 10 CFR Parts 2, 50, and 51 to clarify ambiguities in the current regulations and to codify procedures and terminology that have been used in a number of specific cases. The Commission believes that the proposed amendments would enhance efficiency and uniformity in the decommissioning process for nuclear power reactors. The proposed amendments would allow for greater public participation in the decommissioning process and furnish the licensed community and the public a better understanding of the process as the operating personnel at a nuclear power reactor facility undergo the transition from an operating organization to a decommissioning organization. This

rulemaking would address the process which begins with a licensee's decision to permanently cease operations at the facility and concludes with the Commission's approval of license termination. These rule revisions would reduce regulatory burden while providing greater flexibility for implementing decommissioning activities. This would result in resource savings through a more efficient and uniform regulatory process.

II. Existing Regulatory Framework and Need for the Amendments

The Commission has examined the present regulatory framework for decommissioning, largely contained within 10 CFR 50.82, with additional requirements in 10 CFR 50.75, 51.53, and 51.95, as well as the 10 CFR 50 technical requirements, to ascertain the appropriate regulatory path to take that would ameliorate current licensing concerns without compromising health and safety.

The current rule requires a licensee to submit a preliminary decommissioning plan 5 years before permanent cessation of operations, with a site-specific cost estimate, and an adjustment of financial assurance funds. A detailed decommissioning plan must be submitted to the NRC within 2 years after permanent cessation of operations. At that time, a supplemental environmental report must also be submitted to the NRC describing any substantive environmental impacts that are anticipated but not already covered in other environmental impacts documents. The detailed decommissioning plan contains an updated site-specific cost estimate with decommissioning funds adjusted in an external trust to make up for any shortfall. Currently, prior to approval of the decommissioning plan by the Commission, no decommissioning trust funds can be used (although case-specific exceptions have been made). Finally, aside from the licensee voluntarily informing the public about decommissioning activities, very limited public input or participation is formally required in the current rules. However, public meetings and informal hearings have been held for plants undergoing decommissioning for case-specific situations.

The proposed rule would preserve the substantive elements of the current regulations, provide for greater public participation in the decommissioning process, and allow the licensee to perform decommissioning activities provided certain constraints are met. The proposed rule would make the decommissioning process more responsive to current licensing needs and improve the process in the areas of understandability, efficiency, and uniformity.

During the Phase I process, proposed Sec. 50.82(a) provides that, within 2 years of permanently ceasing operations, a post-shutdown decommissioning activities report (PSDAR) must be submitted to the NRC. The PSDAR would include a description of the licensee's planned

decommissioning activities and a schedule for their accomplishment, an estimate of expected costs, and a discussion addressing whether or not the environmental impacts associated with site-specific decommissioning activities will be bounded by existing environmental impact statements. Upon receipt of the PSDAR, the NRC will announce in the Federal Register receipt of the report, make the PSDAR available for public comment, and announce the location and time of a public meeting to be held in the vicinity of the reactor facility site to discuss the licensee's plans.<SUP>2 Section 50.82(a) further states that after the NRC receives certification of permanent removal of the fuel from the reactor vessel and 90 days after the NRC receives the PSDAR, the licensee may begin to perform major decommissioning activities if the activities meet the requirements in Sec. 50.59. This would generally occur 30 days after the public meeting.

\2\ There is nothing that prevents a licensee from developing and submitting the PSDAR and the NRC from holding the public meeting prior to the permanent cessation of operations.

The provisions of Sec. 50.59 presently allow the licensee to make changes to the facility during operation without express NRC approval if these changes meet the conditions listed in Sec. 50.59, and the licensee prepares and maintains a written safety evaluation that provides the basis for their determination that the planned changes meet the criteria specified in the regulation. The NRC inspects these evaluations periodically to ensure that the licensee is complying with the regulation. To ensure that licensees adequately address the unique circumstances associated with decommissioning activities, the Commission is proposing to include additional criteria for the use of Sec. 50.59 during decommissioning. The criteria would apply to both power and non-power reactors, although non-power reactor licensees could not perform major decommissioning activities until they had an approved decommissioning plan--as in the current rule. The Commission proposes that in using the Sec. 50.59 process for post-shutdown activities the licensee must meet the following criteria which provide that the proposed activities must not: (1) Foreclose release of the site for possible unrestricted use, (2) significantly increase decommissioning costs, (3) cause any significant environmental impact not previously reviewed, or (4) violate the terms of the licensee's existing license. To undertake any activity that would not meet these criteria, the licensee must submit a license amendment request, as is currently the requirement under Sec. 50.59(c).

The Commission proposes to codify the position embodied in the draft policy statement ``Use of Decommissioning Trust Funds Before Decommissioning Plan Approval'' (59 FR 5216; February 3, 1994) that the licensee should be allowed to use decommissioning trust funds subject

to certain criteria. The criteria presented in the draft policy statement have been modified in the proposed rule in response to public comments. The Commission recognizes the need for the licensee to provide adequate financial assurance to complete decommissioning at any time during operation, up to and including the termination of license, and is proposing criteria, along with criteria that specify when and how much of these trust funds can be used, to ensure that licensees maintain adequate funds to complete decommissioning. In accordance with the current rule, the Commission proposes to retain, under Sec. 50.75(f), the requirement for site-specific cost estimates 5 years before and within 2 years after the licensee's declaration of permanent cessation of operations. (For non-power reactors, the Commission

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proposes to require, under Sec. 50.75(f), that a preliminary decommissioning plan be submitted 2 years rather than the current 5 years before permanent cessation of operations because this is a more realistic timing requirement for non-power reactors.) Once the NRC has received the licensee's certification of permanent cessation of operations, decommissioning trust funds could be used by the licensee. However, the withdrawal of funds would be subject to the following criteria: (1) The withdrawals are for expenses for legitimate decommissioning activities consistent with the definition of decommissioning in Sec. 50.2; (2) The expenditure would not reduce the value of the decommissioning trust below an amount necessary to place and maintain the licensee's reactor in a safe storage condition if unforeseen conditions or expenses arise and; (3) The withdrawals would not inhibit the ability of the licensee to complete funding of any shortfalls in the decommissioning trust needed to ensure the availability of funds to ultimately release the site and terminate the license.

The proposed rule would permit, under Sec. 50.82(a)(7), that 3 percent of the generic decommissioning cost amount, specified in Sec. 50.75, could be used by the licensee initially for decommissioning planning. Following the 90-day waiting period after the NRC has received the licensee's PSDAR and upon certification of permanent removal of fuel from the reactor vessel, an additional 20 percent could be used to commence major decommissioning activities. Finally, the proposed rule would require a site-specific cost analysis to be submitted to the NRC prior to the licensee being permitted to use any funding in excess of 23 percent of the generic cost estimate, and, in any case, within 2 years of permanent cessation of operations.

After an optional period of storage (Phase II of the decommissioning process), Sec. 50.82(a)(8) of the proposed rule would require the licensee to complete decommissioning by submitting an application to terminate the license along with a license termination plan. This would initiate Phase III of the decommissioning process.

This process is similar to the requirements in the current rule for a power reactor licensee that has permanently ceased operations and decides to go into a storage mode. The current rule allows a less detailed decommissioning plan initially, with the more detailed plan nearer to the completion of decommissioning because more accurate planning can be accomplished. The termination plan would contain similar elements for consideration as the current rule requires. In particular, the proposed rule would require that the termination plan contain a site characterization, a description of remaining dismantlement activities (if any), plans for site remediation, detailed plans for the final radiation survey, a description of the end use of the site (if restricted), an updated site-specific analysis of remaining decommissioning costs, and a supplement to the environmental report, as required by Sec. 51.53, that describes any new information or significant environmental change associated with the licensee's proposed decommissioning activities.

The NRC would notice receipt of the license termination plan as a license amendment, conduct a public meeting in the vicinity of the site, and provide opportunity for a 10 CFR part 2, subpart L, hearing, as specified in Sec. 2.1201(a)(3), if the spent fuel had been removed from the 10 CFR part 50 licensed site and transferred to an authorized facility. Otherwise, there would be opportunity for a 10 CFR part 2, subpart G, hearing, as provided for in the current rules. The license could not be terminated if fuel were located on the site covered by the 10 CFR part 50 license. The Subpart L hearing is appropriate for the nature of a permanently shutdown facility where the spent fuel has been removed from the 10 CFR part 50 site and transferred to an authorized facility, since the defueled site is analogous to materials licensees that typically use Subpart L hearings for license amendments. Appropriate conforming amendments have been proposed for 10 CFR 2.1205 and 50.91 to reflect the application of subpart L hearings to 10 CFR part 50 license amendments following removal of the fuel from the 10 CFR part 50 licensed site and transfer to an authorized facility. Section 50.82(a)(9) would specify that the Commission would approve the termination plan and the plan would become part of the FSAR. (Similarly, for non-power reactors, the decommissioning plan would become part of the FSAR or equivalent.) As in the current rule, the licensee would then execute the plan and, after this was accomplished and verified by the NRC, the Commission would terminate the license.

In order to clear up various ambiguities in the current rule regarding power reactors, definitions of permanent cessation of operations, permanent removal of fuel from the reactor vessel, major decommissioning activity, major radioactive components and certified fuel handler, would be codified in Sec. 50.2. Because a licensee could choose to undertake major decommissioning activities at the reactor facility 90-days after the NRC receives the PSDAR, it is important to define what ``major decommissioning activity'' means. The definition

chosen is, for a nuclear power reactor, any activity that results in permanent removal of major radioactive components, permanently modifies the structure of the containment, or results in dismantling components for shipment containing greater than class C waste. Accordingly, ``major radioactive components'' would be defined for a nuclear power reactor to comprise the reactor vessel and internals, steam generators, pressurizers, large bore reactor coolant system piping, and other large components that are radioactive.

Written communication requirements for licensee permanent cessation of operations and permanent removal of fuel from the reactor vessel would be specified in Secs. 50.4(b) (8) and (9). The licensee would be required to state the date on which operations will cease, or have ceased, in its certification of permanent cessation of operations. The licensee, in its certification regarding permanent removal of fuel from the reactor vessel, would state the date on which the fuel assemblies were removed and their disposition.

Because of previous case-specific requests the NRC has received from licenses for exemptions from operating requirements in recognition of the permanent shutdown of the facility and permanent removal of fuel from the reactor vessel, the Commission has undertaken an analysis to determine the appropriateness of applying certain 10 CFR part 50 requirements during the post-shutdown period of the facility. The results of a portion of that study are presented in Section III of this rule.

This proposed rulemaking primarily addresses power reactor facilities because, unlike non-power reactor facilities, a delay of up to 60 years between the time of permanent cessation of operations and license termination can occur. Such a situation, especially under circumstances of premature closure, requires special regulatory consideration to deal with licensee decommissioning activities in a timely, efficient, and uniform manner. However, there are three aspects of these proposed regulatory changes that can affect both power and non-power reactor facilities. These aspects are addressed in the proposed rule for purposes of clarification. The proposed rule includes requirements for conditional release situations, as discussed in the proposed decommissioning residual radioactivity

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criteria rule (59 FR 43200; August, 22, 1994). Proposed Sec. 51.53(b) (and correspondingly, under proposed Sec. 51.95 for NRC staff requirements) states that environmental considerations of the decommissioning activities must be explicitly considered during the licensee's request for decommissioning plan or license termination plan approval. Proposed Sec. 50.51(b) states that a license that has expired is not terminated until the Commission notifies the licensee in writing that the license is terminated. The proposed requirement further states that during any period of continued effectiveness beyond the licensee's

stated expiration date, the licensee: (1) Is prohibited from operating the production or utilization facility; (2) Must limit activities to actions necessary to decommission and decontaminate the facility, or actions necessary to maintain the facility, including the storage, control and maintenance of the spent fuel in a safe condition and; (3) Must conduct activities in accordance with all other restrictions applicable to the facility in NRC regulations and provisions of the specific part 50 license for the facility. This provision is consistent with NRC requirements for other licensees and avoids any gaps in the licensing of regulated facilities. This same rationale applies to both power and non-power reactors. Accordingly, this clarification would also pertain to non-power reactors. Finally, proposed Sec. 50.36(c)(6) and (e) clarify that for reactors that are not authorized to operate, existing technical specifications will remain effective until removed or modified by license amendment.