EPRI Guidance for Transition from Operations to Decommissioning

Richard McGrath* Richard Reid

Electric Power Research Institute
3420 Hillview Ave
Palo Alto, California 94504

**corresponding author: rmcgrath@epri.com*

Keywords: decommissioning, transition, regulatory framework

Abstract

A wide range of key activities are necessary after permanent shutdown of a nuclear power plant before active dismantlement of the plant can begin. This period is typically referred to as the transition period. In some cases these activities are prescribed by regulation and in others they may be more practically driven or even optional. In either case, planning for transition activities should optimally take place prior to final shutdown. Additionally, execution of some transition period activities, such as filing required regulatory submittals, may be performed prior to plant shut down.

In addition to general transition period activities such as defueling, management of operational wastes, fulfilling regulatory requirements and changes to plant technical specifications, there are a number of optional activities that may have a long-range impact on future decommissioning activities. This includes activities such as the timing of staff reductions and performance of chemical decontamination.

EPRI is nearing completion of a project to develop guidance for transitioning a nuclear power plant to decommissioning. This project includes the following elements:

- A review of required and recommended transition period activities. For countries where a clear regulatory framework exists, this includes country-specific requirements;
- A review of pending regulatory activities in the US and other countries where there is currently no clear regulatory framework for transitioning to decommissioning;
- A summary of activities that have been performed during the transition period for past and current decommissioning sites, as well as current sites that are actively planning decommissioning activities; and
- Guidance for development of a transition plan for changing from an operational to decommissioning status.

Informed planning of the transition period activities will provide immediate benefits in reducing costs and minimizing the duration of the transition period, as well as longer-term benefits throughout plant decommissioning. Although the EPRI guidance will provide a greater benefit for plants that will shut down in the near future, recently shut down plants and plants currently in safe storage may also benefit from consideration of industry-wide guidance.

Introduction and Background

Transition Period Regulations in the US

Unlike some other countries, the US does not have a formal period for transitioning from operating to decommissioning. The decommissioning process in the US is structured around several regulatory submittals, including:

- Certification of Permanent Cessation of Operations and Permanent Removal of Fuel
- Post Shutdown Decommissioning Activities Report (PSDAR)
- Site-Specific Decommissioning Cost Estimate
- Revisions to Plant Licensing Design Basis Documents
- Defueled Safety Analysis Report

These submittals have been made by the power plant sites currently in transition in the US, each with multiple exemption requests (NRC regulation concerning each exemption also shown) for:

- Emergency Preparedness (Part 50, Appendix E)
- Security Plan and Procedures (CFR Part 73)
- Use of Decommissioning Trust Fund (CFR 50.82)
- Insurance and Financial Protection (CFR 50.54 an Part 140)

Submittal of these documents permits utilities to access portions of the decommissioning trust fund and permits utilities to begin certain dismantling activities.

To streamline the decommissioning licensing process, the NRC is considering rulemaking to establish new regulations to replace the current process of using exemptions such as those listed above. The following list of NRC notices describes the NRC conclusions concerning this proposed rulemaking:

- **SRM SECY-14-0066,** Commission directed staff to report its views on the need for an integrated rulemaking for decommissioning.
- **SRM SECY-14-0118**, Commission directed staff to complete rulemaking in 2019.
- **SECY-15-0014,** NRC Staff Responded to both SRMs and provided high-level schedule and resource needs.

The commission requested the NRC staff to address the following issues in the rulemaking:

- Graded approach to emergency preparedness
  - Fuel in fuel pool
  - Fuel in dry storage
- Lessons Learned
- NRC approval of Post-Shutdown Decommissioning Activity Report
- Maintaining three existing decommissioning options and associated timeframes
- Role of state and local governments and non-governmental stakeholders

The NRC has established a goal for the completion of this rulemaking process in 2019. The NRC will be seeking public participation and comment throughout the rulemaking process.

Experiences in Countries outside the US

In many cases in Europe, dismantlement activities have not been started until all of the spent fuel is removed from the spent fuel pool. Using optimized canister loading which mixes freshly off-loaded fuel with older fuel with lower heat output, it may still be as long as 4 to 5 years after the final shutdown of the plant until all spent fuel can be moved to dry fuel storage.

Canada, France, Germany, Spain and Sweden allow preparatory activities under the operating license during the Transition Period although in the case of France some of them are subject to French Safety Authority information or authorization. These preparatory activities are aimed at reducing the risks or contributing to the preparation of the dismantling phase include: fuel removal from site, radiological characterization, systems decontamination, management of radioactive waste from the operational phase, replacement of systems and components and deactivation of equipment not required. The United Kingdom allows very limited decommissioning activity during the Transition Period.

Spain

Only preparatory activities such as full system chemical decontamination and radiological characterization work were performed at the José Cabrera plant before all the spent fuel had been moved out of the spent fuel pool and into dry fuel storage. After this relocation had been accomplished, the plant operating license was transferred to ENRESA, with approval by the Spanish regulator to begin dismantlement activities.

Germany

The major document governing decommissioning of nuclear power plants in Germany is the Atomic Energy Act (AtG). This document states that after permanent shutdown of a plant, all normal requirements and regulations still apply, with the exception of those concerning power generation. Further, this document states that the normal plant operating licenses still apply during decommissioning. Since decommissioning is typically not covered by the operating license, after permanent shutdown, German plants cannot begin major decommissioning activities (i.e., dismantling) until a new decommissioning-specific license is obtained. Therefore, after permanent shutdown, German plants enter a "post-operational phase" (i.e., a transition phase). This post-operational phase continues until the plant has applied for and received a decommissioning license from the appropriate Länder[1] authority.

During the post-operational phase, the normal plant operating license is still in effect and thus German plants may still conduct activities covered by the normal operating license. These activities include:

- Defueling of nuclear fuel from the reactor

[1] The Länder are the 16 Federal States of Germany.

- Loading of nuclear fuel into storage containers and storage in the onsite interim storage facilities (similar to ISFSI in US plants)
- Utilization of radioactive substances and disposal of operational wastes
- Decontamination of the facility and systems
- Sampling of systems and components
- Dismantling of non-nuclear facilities (e.g., office buildings, parking lots, etc.)

Switzerland

The Mühleberg NPP, a BWR with the Spent Fuel Pool located in the Reactor Building is scheduled for permanent shutdown in 2019. This will be the first power plant to be decommissioned in Switzerland. Regulations and regulatory guidance for the transition from operations to active decommissioning is being developed in Switzerland.

Discussion

A wide range of key activities are necessary after permanent shutdown of a nuclear power plant before active dismantlement of the plant can begin. For example, defueling, management of operational wastes, fulfilling regulatory requirements, staffing plan, changes to plant technical specifications and full-system chemical decontamination to name a few. In some cases these activities are prescribed by regulation and in others they may be more practically driven or even optional. Planning for transition should optimally take place prior to final shutdown and execution of some transition period activities, such as filing required regulatory submittals, may be performed prior to plant shutdown.

An EPRI project is in progress which will be developing guidance for transitioning from operational to decommissioning status. An overview and the goals of the project are:

- Compile country-specific transition period regulations
- Countries will be selected to provide a wide range of regulations (i.e., structured vs. unstructured transition)
- Compile industry transition period operating experience
- Identify activities that can be performed/planned for before shutdown
- Identify long-lead activities that should be prioritized
- Identify cost-saving activities that should be performed early after shutdown
- Provide guidance for the development of a plan to transition from operational to decommissioning status

Motivation for the EPRI Project

The cost of decommissioning is highly influenced by overall staffing costs, which is related to the overall length of decommissioning. Figure 1 from EPRI report # 1023025, show that staffing costs make up, on the average, 43.5 % of the total decommissioning costs in the US. It is anticipated that the guidance developed in this EPRI work will help shorten the length of the transition period, and thus shorten the overall length and cost of decommissioning.

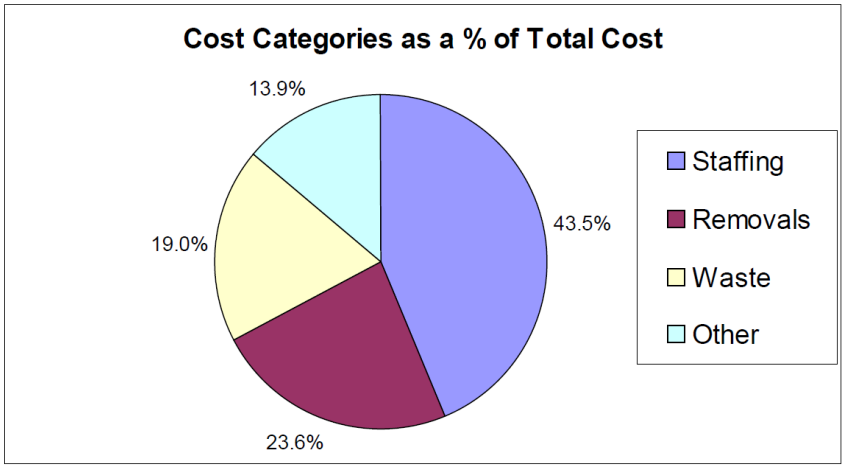

Figure 1: Breakdown of Decommissioning Costs in the US

Reactor	Type	Commercial Operation	Shutdown	Years Operational	Status [a]	Fuel Onsite
GE VBWR	BWR	Oct-57	Dec-63	6.1	SAFSTOR	No
Pathfinder	Superheat BWR	Jul-66	Sep-67	1.1	License Terminated	No
Saxton	PWR	Mar-67	May-72	5.2	License Terminated	No
Fermi 1	Fast Breeder	Aug-66	Sep-72	6.1	SAFSTOR	No
Indian Point 1	PWR	Oct-62	Oct-74	12.1	SAFSTOR	Yes
Peach Bottom 1	HTGR	Jun-67	Oct-74	7.4	SAFSTOR	No
Humboldt Bay 3	BWR	Aug-63	Jul-76	12.9	DECON	Yes
Dresden 1	BWR	Jul-60	Oct-78	18.3	SAFSTOR	Yes
Three Mile Island 2	PWR	Dec-78	Mar-79	0.2	SAFSTOR [b]	No
LaCrosse	BWR	Nov-69	Apr-87	17.5	DECON	Yes
Millstone 1	BWR	Mar-71	Jul-88	17.4	SAFSTOR	Yes
Rancho Seco	PWR	Apr-75	Jun-89	14.2	ISFSI Only [c]	Yes
Shoreham	BWR	Aug-86	Jun-89	2.9	License Terminated	No
Fort St. Vrain	HTGR	Jul-79	Aug-89	10.1	ISFSI Only	Yes
Yankee Rowe	PWR	Jul-61	Oct-91	30.3	ISFSI Only	Yes
Trojan	PWR	May-76	Nov-92	16.5	ISFSI Only	Yes
San Onofre 1	PWR	Jan-68	Nov-92	24.9	DECON	Yes
Zion 2	PWR	Sep-74	Sep-96	22.0	DECON	Yes
Maine Yankee	PWR	Dec-72	Dec-96	24.0	ISFSI Only	Yes
Connecticut Yankee	PWR	Jan-68	Dec-96	29.0	ISFSI Only	Yes
Zion 1	PWR	Dec-73	Feb-97	23.2	DECON	Yes
Big Rock Point	BWR	Mar-63	Aug-97	34.4	ISFSI Only	Yes
Crystal River 3	PWR	Mar-77	Feb-13	36.0	SAFSTOR	Yes
Kewaunee	PWR	Jun-74	May-13	38.9	SAFSTOR	Yes
San Onofre 2	PWR	Aug-83	Jun-13	29.9	DECON	Yes
San Onofre 3	PWR	Apr-84	Jun-13	29.2	DECON	Yes
Vermont Yankee	BWR	Nov-72	Dec-14	29.2	SAFSTOR	Yes

Decomissioning Completed

a) ISFSI = Independent spent fuel storage installation, which is a stand-alone facility within the plant constructed for the interim storage of spent nuclear fuel. "ISFSI Only" means the plant license has been reduced to include only the ISFSI.
b) TMI 2 is in a post-defueling monitored storage (PDMS) state, where the plant is in SAFSTOR but the fuel has been removed.
c) Some low-level waste is also stored at Rancho Seco in addition to its ISFSI.

Figure 2: Status of Permanently Shutdown Plants in the US

US Transition Period Experience

Figure 2 show the status of the permanently shutdown plant in the US. The EPRI Transition Period Guidance Report will summarize the experiences at the ten plant sites outlined in purple. Additionally, although the Oyster Creek plant has not been shutdown, transition plans have been made for that plant.

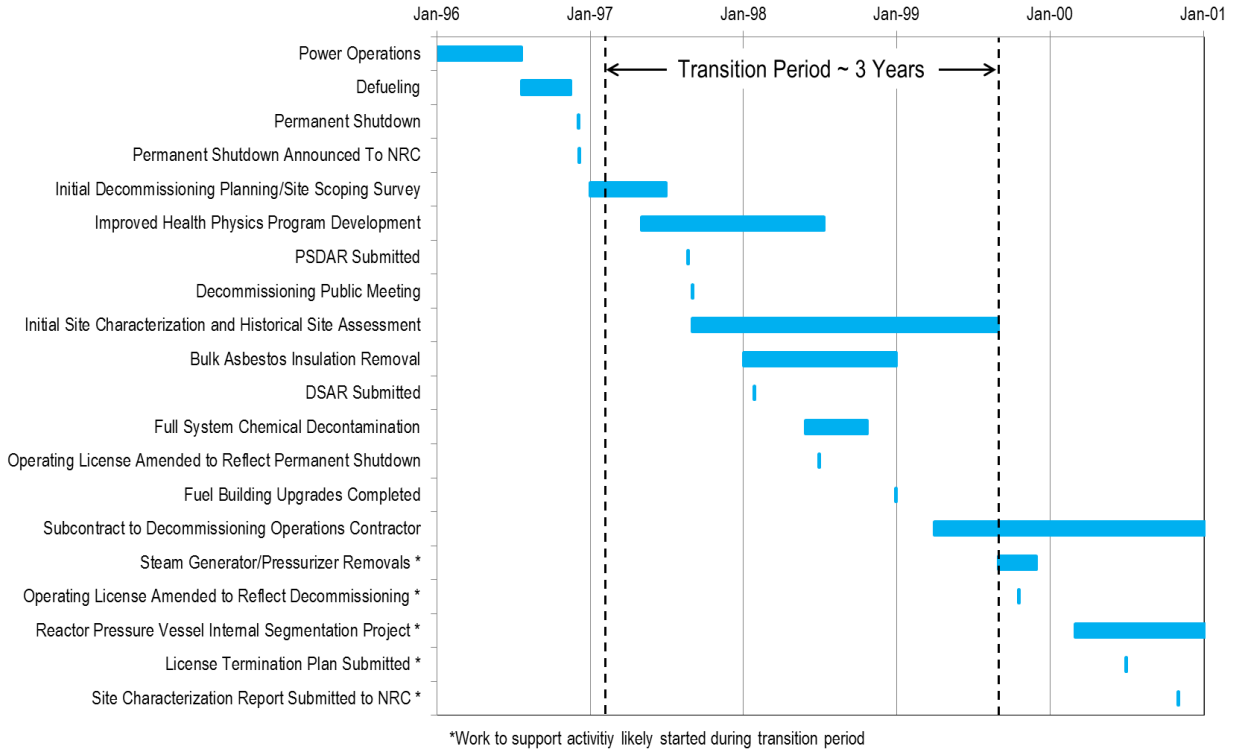

Figure 3: Transition & Early Decommissioning Activities at the Connecticut Yankee Plant

Figure 3 shows the transition period and early decommissioning activities at the Connecticut Yankee plant. Although the transition was almost 3 years, this period was extended somewhat by an NRC required improvement of the Health Physics Department. The experience for San Onofre Units 2 & 3 is that similar transition period activities were accomplished in 2 years.

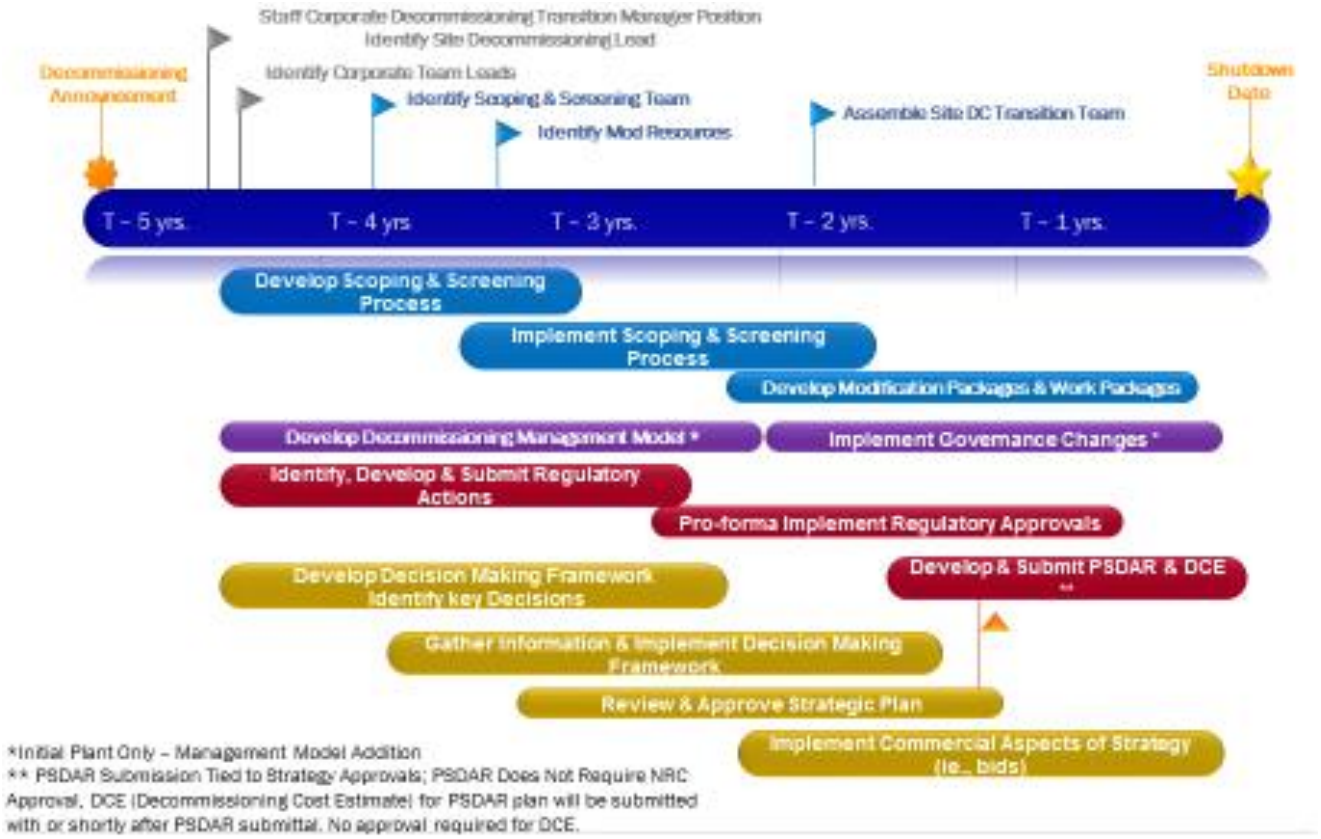

Figure 4: Exelon Nuclear Management Model – Transition Period Timeline

Exelon operates a fleet of nuclear power plants in the US and has recognized the importance of early decommissioning planning. Figure 4 illustrates the Exelon management timeline for performance of decommissioning planning activities and the preparation of decommissioning licensing documents. It is noteworthy that this time line starts 5 years before the planned shutdown of a power plant.

The following is a listing of typical transition period activities in the US:

- Cost estimating
- Preparation/submittal of regulatory submittals
- Systems, Structures and Component (SSCs) Rr-categorization
- Revised Technical Specifications
- Cold and Dark Program (repower certain systems)
- Project Management Model
- Re-design Work Control Process
- Develop Communications Plan
  - Both internal and external
- Human Resources
  - Retention of key staff
  - Labor agreement impacts

    - Relocation of other staff
- Perform Historical Site Assessment and Initial Site Characterization
- Disposal of Operational (Legacy) Wastes
- Fuel Building modifications to isolate from other plant systems
- Certified Fuel Handler Program
- Transfer of spent fuel to dry casks
    - Design of the Dry Fuel Storage System
    - Building and system modifications to support the Dry Fuel Storage System
    - Fabrication of Dry Fuel Storage Canisters, Storage Cells and other related equipment
    - Design and construction of the ISFSI
- Dismantling of non-nuclear facilities
- Upgrade plant/infrastructure (e.g. rail) to facilitate removal of wastes
- Full System Chemical Decontamination
- Hot Spot Reduction
- Asbestos and flammable materials removal
- Preparation for post-transition decommissioning activities
    - Major component removal planning
    - Reactor Vessel and Internals Segmentation planning
    - Balance of plant dismantlement

Summary and Conclusions

Informed planning of the transition period activities will provide immediate benefits in reducing costs and minimizing the duration of the transition period, as well as longer-term benefits throughout plant decommissioning. EPRI is nearing completion of a project to develop guidance for transitioning a nuclear power plant to decommissioning. In addition to summarizing experiences with completed transition periods in the US, The EPRI Transition Period Guidance Report will:

- Continue to compile transition period operating experience
- Summarize German, French, Spanish, and Swiss transition period regulations
- Evaluate regulations and operating experience to develop guidance for transitioning from operating to decommissioning

The EPRI Transition Period Guidance Report is scheduled to be completed in the middle of 2016.

References

EPRI Report #1023025, *Decommissioning Experiences and Lessons Learned: Decommissioning Costs*, 2011

EPRI Report # 1000093, *Preparation for Decommissioning – The Oyster Creek Experience*, June 2000