

EPRI Guidance for Transitioning from Operation to Decommissioning at Nuclear Power Plants - 17438

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ABSTRACT

A wide range of key activities are necessary after permanent shutdown of a nuclear power plant and before active dismantlement of the plant can begin. This period between permanent shutdown and the start of active dismantlement is typically referred to as the transition period (or the post-operational phase). In some cases, these transition activities may be prescribed by regulation or performed in the absence of regulations, while in other cases they may be more practically driven or even optional. In either case, it is often unclear what activities are needed and when/how those activities should be conducted to most efficiently transition from operational to decommissioning status while maintaining radiological safety and the protection of the public.

The Electric Power Research Institute has prepared a report that presents experiences and guidance for transitioning from an operational to decommissioning status based on US and international decommissioning regulations and plant experiences. Regulations and experiences in a number of countries were considered, including US, Germany, France, Spain, and Switzerland. Best practices and lessons learned related to transitioning to decommissioning are identified, and guidance is presented for developing a plan to transition from normal operations to decommissioning for several scenarios, including:

- Transition to DECON (immediate dismantling) for a planned shutdown
- Transition to SAFSTOR (deferred dismantling) for a planned shutdown
- Transition to DECON (immediate dismantling) for an unplanned shutdown
- Transition to SAFSTOR (deferred dismantling) for an unplanned shutdown

Further, the EPRI report contains guidance for currently operating plants that do not anticipate permanent shutdown in the near future to help minimize the cost and impact of an unexpected permanent shutdown if such a scenario were to occur.

INTRODUCTION

The first step in decommissioning planning is to develop a high level plan, with the objective of addressing and understanding critical decommissioning issues/questions. During the development of this plan, plant personnel should review applicable regulations, available guidance on decommissioning, past decommissioning experiences, and work with industry experts who have actual decommissioning experience. The EPRI report summarized in this paper provides guidance for transitioning from operation to decommissioning in several scenarios. This guidance may be consulted when developing a plan to transition from operations to decommissioning.

BACKGROUND

Unlike some other countries, the US does not have a formal transition period. The decommissioning process in the US is structured around the submittal of several documents to the US Nuclear Regulatory Commission. Several of these regulatory submittals directly affect the transition period, including (Reference 1):

- Certifications of Permanent Cessation of Operations and Permanent Removal of Fuel
- Post Shutdown Decommissioning Activities Report (PSDAR)
- Site-Specific Decommissioning Cost Estimate (DCE)
- Revisions to Plant Design Basis Documents

Submittal of these documents permits utilities to access portions of the decommissioning trust fund (DTF), and permits utilities to begin certain dismantling activities. Figure 1 shows a summary of these regulatory submittals, including the financial and legal restraints that exist before and after each document is submitted and approved.

After the certifications of permanent cessation of power operation and permanent removal of fuel are received by the NRC, plants may begin certain decommissioning activities. However, "major decommissioning activities," defined as "...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..." are prohibited until the plant provides the public and regulator with information describing the planned decontamination and dismantling activities in a PSDAR. Further, as shown in Figure 1, prior to submittal of the PSDAR, plants may only use up to 3% of the generic minimum DTF amount.

The PSDAR is typically a relatively brief document that describes the plant's planned decommissioning activities, including the following required items:

- A description of the planned major decommissioning activities, including which decommissioning method will be used (i.e., prompt decontamination and dismantlement (DECON), long term storage (SAFSTOR), or a combination of the two);
- A schedule of the planned decommissioning activities, including the relationships between decommissioning activities;
- A Decommissioning Cost Estimate (DCE); and
- An evaluation of environmental impacts associated with decommissioning the site.

Event	Decommissioning Activities Permitted	% of Decommissioning Trust Fund Available
Normal Operation		
Cert. of Permanent Cessation of Operations Submitted	Only activities permitted by normal operating license: •Decontamination •Removal of Operating Waste •Site Characterization •Etc. Major decom activities prohibited	3% *
Plant Design Basis Documents (T S, FSAR) Updated to Reflect Permanent Shutdown **		Funds may only be used for planning purposes
Cert. of Permanent Defueling Submitted		
PSDAR Submitted		
PSDAR + 90 days	Major decom activities permitted	23% *
Site-Specific Decom Cost Estimate Submitted		100%

* These values refer to a percent of the generic minimum amount required for decommissioning, which is defined in the regulation.

** TS = Technical Specifications; FSAR = Final Safety Analysis Report

Fig. 1 Major Decommissioning-related Submittals in the US

After permanent cessation of power operations, plants must continue to follow all surveillances and procedures required by the Technical Specifications (TS) and similar documents to maintain the plant systems (e.g., structures, systems, and components (SSCs) important to safety during normal operation) in an operational-ready state. Since most plant systems are not required during the decommissioning process, these operations are unnecessary, which results in increased staffing requirements and increased costs. To eliminate the need to conduct these unnecessary operations, plants must revise the plant design basis documents, including the plant TS and the final safety analysis report (FSAR) /

updated final safety analysis report (UFSAR), to reflect the permanently shut down status of the plant. This process involves identification of the accidents that are still relevant in the permanently defueled state, reclassifications of SSCs that are no longer important for safety, revisions to plant procedures, and revisions to the UFSAR and TS. After permanent shutdown, the revision process for these documents is the same as during normal operation. After fuel has been permanently removed from the reactor, the revised versions of these documents are often referred to as the permanently defueled Technical Specifications (PDTS) and the defueled safety analysis report (DSAR).

The PDTS is an extensive revision of the TS. Since most TS do not apply during permanent shutdown, typically many TS sections are deleted in their entirety from the PDTS, and many TS sections are significantly reduced in scope. Typically, only TS related to the safe storage of the spent fuel and administrative/ organizational items are retained in the PDTS. After removal of the spent fuel from the spent fuel pool (SFP), the PDTS is revised again to eliminate those sections on the SFP.

The DSAR is the principle licensing source document describing the pertinent equipment, structures, systems, operational constraints and practices, accident analyses, and decommissioning activities associated with the defueled condition. The DSAR is applicable throughout the plant decommissioning. New DSAR revisions must be submitted to the NRC at least every 24 months for plants that have submitted certification that the plant has been permanently shut down.

Other regulatory submittals that are not strictly required before engaging in decommissioning activities, but in many cases, it is cost effective to submit these documents as soon as possible during the transition period to eliminate regulatory requirements that are no longer applicable during decommissioning. These submittals include:

- License Amendment Requests for Emergency Plan (EP) Reductions & Permanently Defueled EP
- Permanently Defueled Technical Specifications
- Security Plan Exemptions
- Rescission of NRC Orders
- Decom. Trust Fund Access Exemption
- Insurance Exemptions
- Certified Fuel Handler Training Program
- Decommissioning QA Plan
- Records Retention Exemption

The NRC has identified several decommissioning-related issues warranting review for potential changes to regulations and for development of enhanced guidance. The NRC has noted that there is a high likelihood these regulations will not be

issued until 2020 (Reference 2). Potential changes identified by the NRC that could affect the decommissioning transition process include new regulations that could be developed to (Reference 3):

- Specify appropriate levels of EP requirements for decommissioning plants.
- Reduce insurance requirements after certain spent fuel management milestones have been achieved.
- Reduce security/safeguards requirements during decommissioning.
- Specify appropriate levels of training and qualifications for operators and support staff at decommissioning plants.
- Divide regulations on "Backfitting," into two parts, with one part for operating plants and one part for decommissioning plants.

Further, the NRC staff has also noted that the following items related to transitioning will be reviewed to determine if any potential regulation changes are needed:

- The advisability of requiring a licensee's PSDAR to be approved by NRC.
- The appropriate role of state and local governments and non-governmental stakeholders in the decommissioning process.

Typical Transition Period Regulations Outside the US

Unlike US, after permanent shutdown in a number of countries outside the US, a specific decommissioning license is needed before major decommissioning activities permitted. Figure 2 shows a typical sequence of required regulatory approval in Europe. Typical aspects for these regulations outside the US are:

- To obtain a "Decommissioning License", plants must demonstrate adequate technical and financial capabilities to conduct the decommissioning.
- During transition period, plants may conduct activities covered by the normal operating license (including decontamination, disposal of operational wastes, etc.).
- Review and approval of the license application typically takes 3-5 years depending on whether the preparation and application process was begun before or after the final shutdown of the plant.
- In some countries, dismantling activities cannot begin until all fuel is removed from SFP.

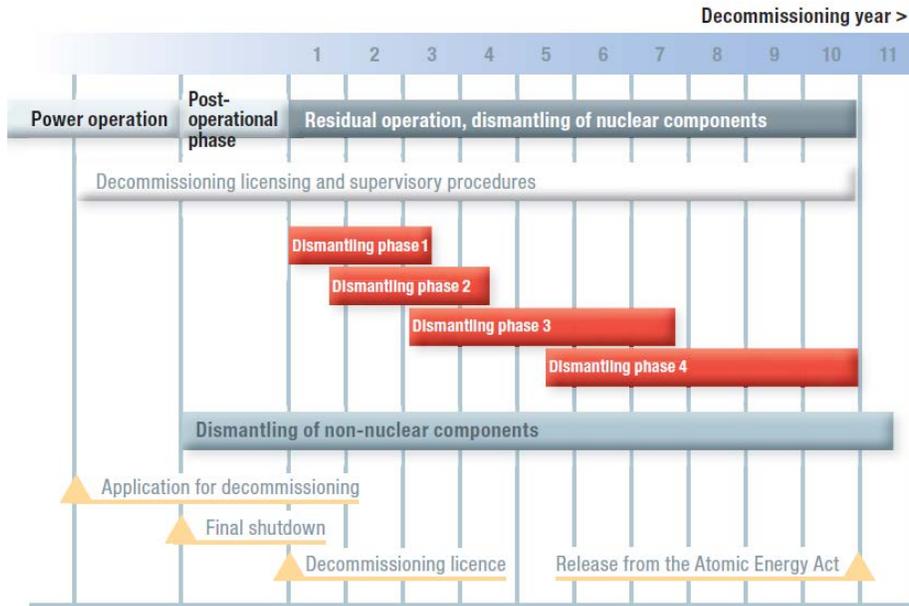


Fig. 2 Typical Regulatory Approvals Required in Europe

DISCUSSION

EPRI Review of Transition Period Experiences in the US

As part of the work done under this EPRI project, the experiences with transitioning from normal operations to decommissioning at eight US plants were reviewed. These experiences are summarized in Figure 3, along with other relevant information. As shown in this table, the transition experiences discussed include both unplanned and planned permanent shutdowns, both transitions to DECON (immediate dismantling) and to SAFSTOR (deferred dismantling), and both completed and in-progress decommissioning transitions.

Plant Name	Shutdown Date	Initial Decommissioning Strategy	Months of Decommissioning Preparation	Transition Period Duration	Current Status
Connecticut Yankee	Dec-96	DECON	0	2.8 Years	ISFSI Only
Maine Yankee	Aug-97	DECON	8-20	1.8 Years	ISFSI Only
Zion 1	Feb-98	SAFSTOR	1	2.4 Years	DECON
Zion 2	Feb-98	SAFSTOR	1	2.4 Years	DECON
Oyster Creek	N/A	DECON	33	N/A	Normal Operation
Crystal River 3 (CR3)	Feb-13	SAFSTOR	0	2.4 Years	SAFSTOR
Kewaunee	May-13	SAFSTOR	7	1.6 Years	SAFSTOR
San Onofre 2 (SONGS 2)	Jun-13	DECON	0	4.1 Years	DECON
San Onofre 3 (SONGS 3)	Jun-13	DECON	0	4.1 Years	DECON
Vermont Yankee (VY)	Dec-14	SAFSTOR	16	1.3 Years	SAFSTOR

Fig. 3 Summary of Transition Period Experiences at Selected US Nuclear Power Plants

As can be seen in Figure 3, there is a clear relationship between the length of the transition period and the period of time spent preparing for the decommissioning before the final shutdown of the plant. This illustrates that it is very cost beneficial to start preparing for the decommissioning while the plant is still running.

Summary of EPRI Guidance

With the relationship described in mind, the EPRI project defined transitioning guidance for nuclear power plant sites. The following summarizes that guidance:

Figure 4 below shows the transition period activities for a plant that has an unplanned shutdown and is to be promptly decommissioned. For comparison, Figure 5 shows a plant that began preparing for the final shutdown 3 years before it was to occur. In the latter case, the transition period is one year shorter than the unplanned shutdown case.

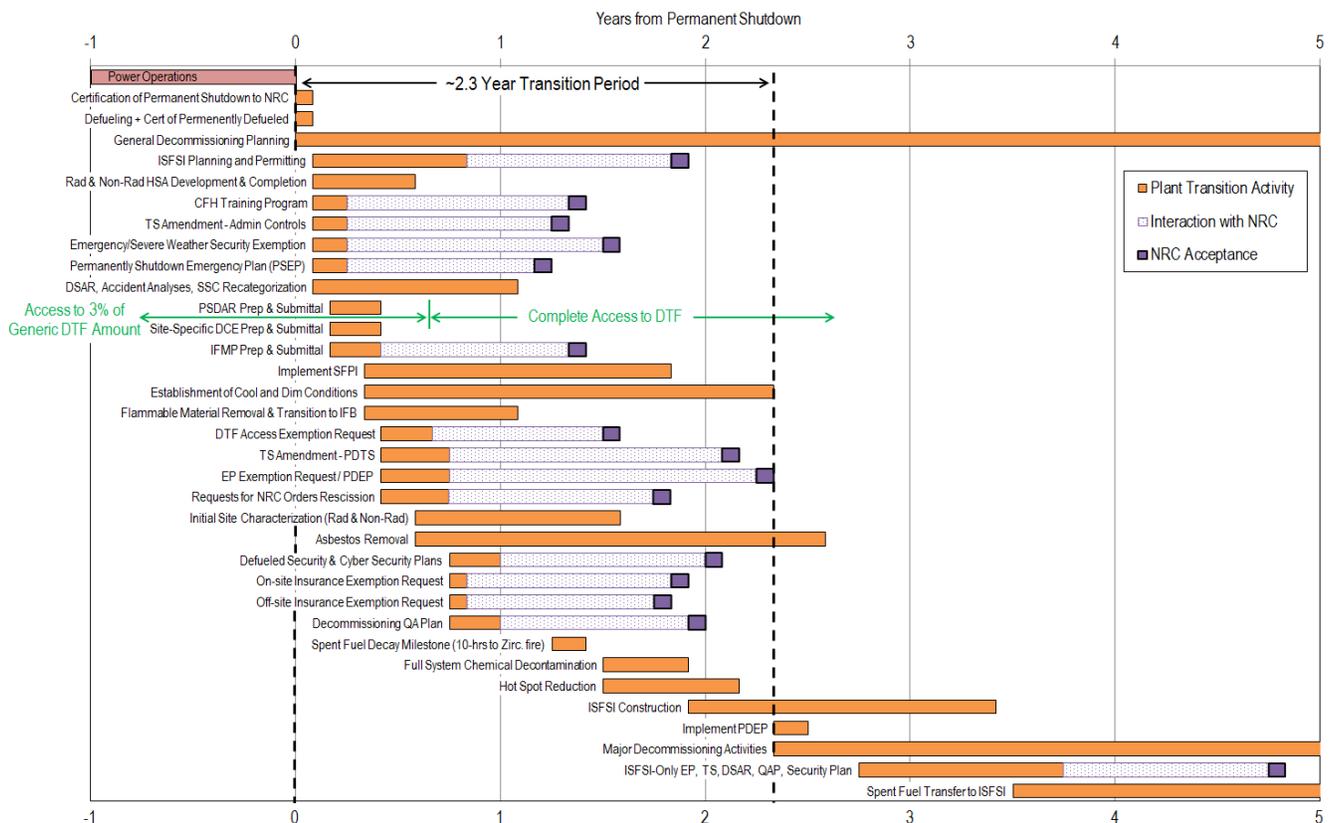


Fig. 4 Typical Early Decommissioning Activities for an Unplanned Shutdown

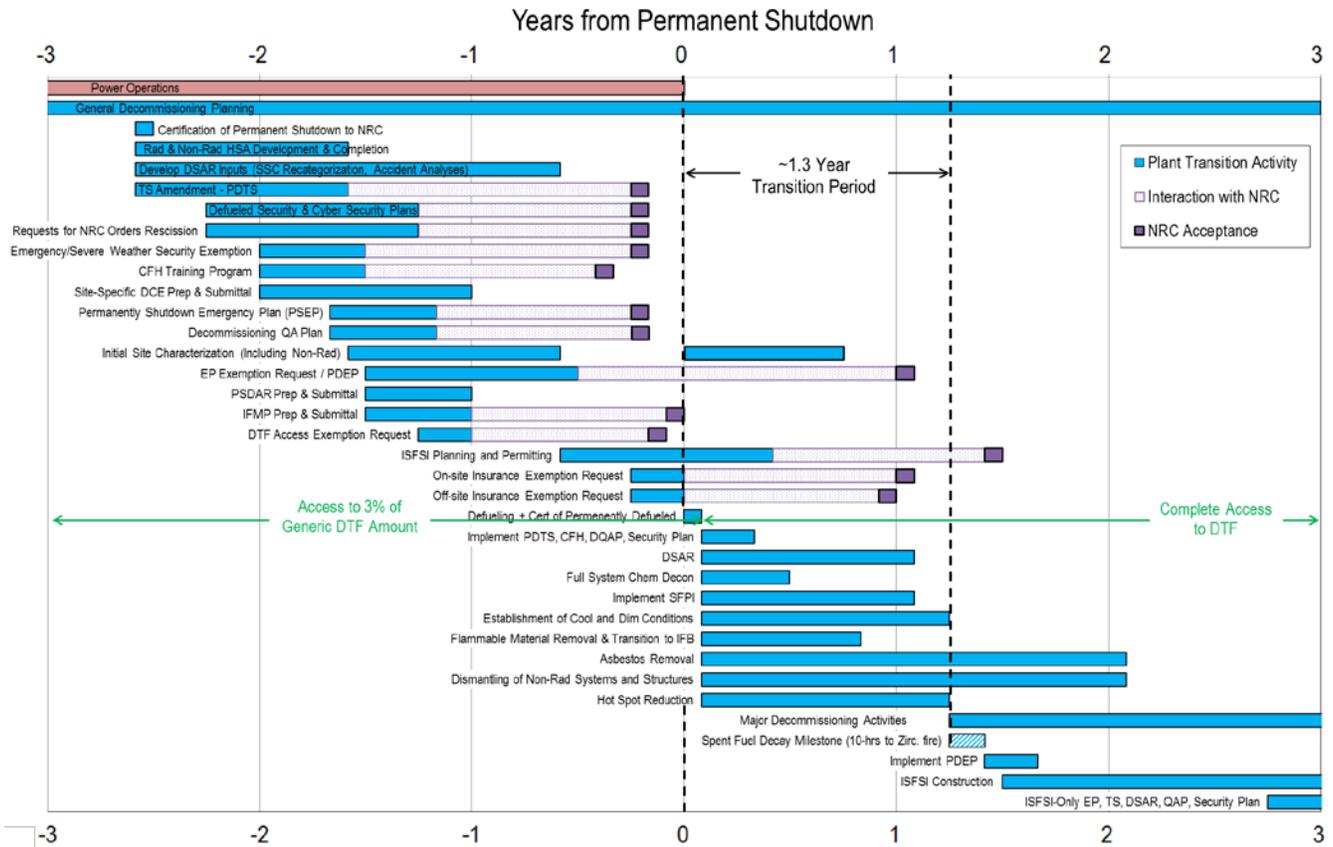


Fig. 5 Typical Early Decommissioning Activities for a Planned Shutdown

Figures 4 and 5 illustrate why plants should begin planning for decommissioning at least 3 years prior to the date of permanent shutdown using the following actions:

- Create a decommissioning planning team during operations and relieve this planning team members of their operational duties. The Decommissioning Planning Teams tasks:
 - Review applicable regulations
 - Review decommissioning experiences and available guidance
 - Visit decommissioning sites
 - Work with industry experts
 - Prepare decommissioning regulatory submittals and submit to regulator as regulatory submittals will not be significantly affected by short term plant operations or changes to decommissioning plans
 - Develop plans that address critical decommissioning issues/questions
 - Develop a Human Resources Plan
 - Develop a Communication Plan
 - Develop a decommissioning strategy (Future Site Use, Prompt/Delayed Decommissioning)

- Get involved in decommissioning regulation development / revision process
- Maintain comprehensive historical site assessment during normal operation

Additional EPRI Guidance

A partial listing of additional EPRI decommissioning guidance documents that were used to prepare the subject EPRI report on transitioning is summarized below. The scope of these other documents is slightly different than the subject report (e.g., more detailed guidance/experiences for a specific decommissioning activity, a greater focus on planning for the decommissioning itself rather than just the transition period, etc.).

- Decommissioning Planning:
 - EPRI 1003025, *Decommissioning Pre-Planning Manual* (Reference 4): This document provides guidance and recommendations for decommissioning pre-planning, and is based predominantly on the decommissioning experiences at Connecticut Yankee, Oyster Creek, Maine Yankee, and Yankee Rowe.
 - EPRI 103510, *Decommissioning Planning: Experiences from U.S. Utilities* (Reference 5): This document provides guidance and recommendations for decommissioning planning, based predominantly on the Zion decommissioning experience.
 - EPRI 1000093, *Preparing for Decommissioning: The Oyster Creek Experience* (Reference 6): This document summarizes the Oyster Creek experience with pre-planning for decommissioning from 1997-2000 for a planned shutdown in 2000 that was since deferred to 2019.
 - EPRI TR-109032 *Regulatory Process for Decommissioning Nuclear Power Reactors* (Reference 7): This document provides a summary of the regulatory requirements applicable, or no longer applicable, to nuclear power plants at the time of permanent shutdown through the early decommissioning stage (as of 1998).
- Plant Decommissioning Experience Summary Documents:
 - EPRI 1021107, *Nuclear Plant Decommissioning Lessons Learned* (Reference 8): This report provides a condensed summary of decommissioning-related lessons learned from decommissioning projects in 1995-2010.
 - EPRI 1013511, *Connecticut Yankee Decommissioning Experience Report: Detailed Experiences 1996-2006* (Reference 9): This document provides a summary of the Connecticut Yankee Decommissioning Experience.
 - EPRI 1009410, *Capturing Historical Knowledge for Decommissioning of Nuclear Power Plants: Summary of Historical Site Assessments at Eight Decommissioning Plants* (Reference 10): This report presents a summary of the approach to obtain the required inputs for the HSA and the main results of the HSA for eight decommissioning plants.

CONCLUSIONS

It is anticipated that the guidance published in EPRI Report # 3002007551, *Guidance for Transitioning from Operation to Decommissioning for Nuclear Power Plants* (2016), will assist utilities to effectively plan to transition from operational to decommissioning status. Additionally, plants that have recently shutdown and plants that are currently in safe storage may also benefit from consideration of this guidance. Informed planning of the transition from operational to decommissioning status will provide immediate benefits, including reduced costs and minimization of the duration of the transition period, as well as longer-term benefits throughout plant decommissioning.

REFERENCES

1. US NRC Regulatory Guide 1.184, "Decommissioning of Nuclear Power Reactors," October 2013, Revision 1.
2. M. Satorius, "Anticipated Schedule and Estimated Resources for a Power Reactor Decommissioning Rulemaking," January 30, 2015. SECY-15-0014.
3. C. Einburg, "Advanced Notice of Proposed Rulemaking: Regulatory Improvements for Decommissioning Power Reactors and Notice of Upcoming Public Meeting (STC-15-083)," December 4, 2015. NRC ADAMS Accession No. ML15296A450. STC-15-083.
4. EPRI Report # 1003025, *Decommissioning Pre-Planning Manual*
5. EPRI Report # 103510, *Decommissioning Planning: Experiences from U.S. Utilities*
6. EPRI Report # 1000093, *Preparing for Decommissioning: The Oyster Creek Experience*
7. EPRI Report # TR-109032 *Regulatory Process for Decommissioning Nuclear Power Reactors*
8. EPRI Report # 1021107, *Nuclear Plant Decommissioning Lessons Learned*
9. EPRI Report # 1013511, *Connecticut Yankee Decommissioning Experience Report: Detailed Experiences 1996-2006*
10. EPRI Report # 1009410, *Capturing Historical Knowledge for Decommissioning of Nuclear Power Plants: Summary of Historical Site Assessments at Eight Decommissioning Plants*