ELECTRIC POWER RESEARCH INSTITUTE

Decommissioning Planning

Experiences from US Utilities

Technical Report

Decommissioning Planning

Experiences from U.S. Utilities

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REPORT SUMMARY

The purpose of this EPRI Technical Report is to provide a series of pre-planning guidance documents for the decommissioning of a nuclear power plant. This guidance is based in part upon Nuclear Decommissioning Plans (NDPs) developed by Commonwealth Edison (now Exelon) following the premature closure of Zion Station in 1998 as well as from other industry references and experience. These NDPs focus on the planning activities over the period from prior to final shutdown through the transition period into decommissioning.

Background
Several U.S. nuclear power plants entered decommissioning in the 1990's. These decommissioning projects were all due to the premature end of operations for these power reactors. In some cases, utilities documented the processes and procedures used to transition a facility from power operations into decommissioning. EPRI has captured the experience from a number of these decommissioning projects including:

- Shoreham Decommissioning: Project Summary and Lessons Learned
- Yankee Rowe Decommissioning Experience Report
- Preparing for Decommissioning: The Oyster Creek Experience
- Decommissioning Pre-Planning Manual – Final Report

This report continues the EPRI program of capturing decommissioning experience using Nuclear Decommissioning Plans (NDPs) based on experience gained with the shutdown and transition into decommissioning of Zion Station in 1998.

Objective
To summarize the decommissioning experience of a power reactor transitioning from power operations into decommissioning and to provide lessons learned for future plants entering decommissioning.

Approach
The project team reviewed copies of Nuclear Decommissioning Plans which were developed based on the experience gained during the premature shutdown of Zion Station in 1998. These plans were reviewed to determine those aspects with general applicability to power reactors in the development of plans for decommissioning. Those aspects of the NDPs which had generic applicability for the planning or conduct of power reactor decommissioning were summarized. Where appropriate, additional decommissioning experience and resources were used in the development of this document.

Results

The decommissioning experience and pre-planning processes developed based from industry sources and the premature shutdown of Zion Station is presented in the areas of:

- Strategy and Decision Analysis
- Near-Term Site Operations
- Communications and Human Resources
- Licensing Activities
- Stakeholder Interaction
- Engineering
- Initial Site Characterization

EPRI Perspective

Planning is a crucial ingredient of successful decommissioning projects. The premature shutdown of several nuclear power plants in the 1990s resulted in considerable front end project cost due to lack of predefined fundamental plans. Such items as staff reductions, and basic project strategy had to be developed before major work could be initiated. This project report will provide information developed in earlier planning efforts as a guide to future pre-decommissioning planning. Capturing the lessons learned from recent plant experiences remains an important part of the EPRI program. Used in conjunction with an earlier EPRI Report *Decommissioning Pre-Planning Manual – Final Report*, this report provides a comprehensive roadmap for developing a plan for nuclear plant decommissioning.

Keywords

Decommissioning
Pre-Planning
Site Shutdown

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INTRODUCTION

Report Introduction

The purpose of this EPRI Technical Report is to provide a series of pre-planning guidance documents for the decommissioning of a nuclear power plant. This guidance is based in part upon Nuclear Decommissioning Plans (NDPs) developed by Commonwealth Edison (now Exelon) following the premature closure of Zion Station in 1998 as well as from other industry references and experience.

Overview of Nuclear Decommissioning Plans

On January 15, 1998, the Commonwealth Edison Board of Directors decided to permanently cease operations at the Zion Nuclear Power Station. The decision was driven by plant economics with the onset of utility deregulation in Illinois. At the time of the Zion Station shutdown, Commonwealth Edison owned and operated a total of thirteen power reactors. The project was aimed at gathering information and experience based on the shutdown and transition of Zion Station from operations into decommissioning. Other available industry sources were also used for this project. The specific task was to use this information and experience to develop a series of high level planning documents which could be used in the eventuality of future premature reactor shutdowns. These high level plans were called Nuclear Decommissioning Plans or NDPs. The objectives of these NDPs were:

- To provide a standardized approach to decommissioning that is adaptable to various decommissioning strategies, a PWR or BWR, one or multiple units per site;
- To provide for safe, cost effective decommissioning; and,
- To minimize the adverse effects of the shutdown on the stakeholders.

There were three guiding principles for the development of the NDPs:

- *Focus on safety* - Activities related to nuclear, radiological, and personnel safety will be conducted in accordance with industry standards.
- *Fairness to people* - Minimize the adverse impact on all stakeholders in a fair manner.
- *Regulatory credibility* - The performance of decommissioning activities described in the plans will provide for compliance of all regulations.

The NDPs were developed to be reference or guidance documents for future managers that would be tasked with various aspects of the planning or conduct of decommissioning. Each NDP included a Scope or Objective, but differing levels of detail. Those NDPs which dealt with aspects of decommissioning with a clear relation to regulatory guidance (e.g., submittal of a Post Shutdown Decommissioning Experience Report or PSDAR) tended to provide additional detail. Conversely, those NDPs dealing with aspects of decommissioning without firm regulatory requirements (e.g, human resources or communications), tended to be conceptual and discussion based. As such, the level of detail presented in this report also varies widely from section to section.

Decommissioning Process Description

To better understand the description of the decommissioning process that follows, these terms need to be defined first:

- SAFSTOR - A decommissioning strategy in which the facility is placed in a safe and stable condition and maintained in that state until it is subsequently decontaminated and dismantled to levels that permit license termination. During SAFSTOR, a facility is left intact, but the fuel has been removed from the reactor vessel and radioactive liquids have been drained from system and components and then processed.
- DECON - A decommissioning strategy in which the equipment, structures, and portions of the facility and site that contain radioactive contaminants are removed or decontaminated to a level that permits termination of the license shortly after cessation of operations.
- Spent Fuel Nuclear Island (SFNI) - A spent fuel storage option in which the fuel storage building (typical of a PWR) is modified to a totally independent facility for the wet storage of fuel. There is no reliance on any site-wide systems such as Service Water, Emergency Power, etc. so that decommissioning related site activities would not impact the safe storage of fuel.
- Dry Storage of Fuel - A spent fuel storage option in which the spent fuel is stored in a cask system that does not required a liquid cooling medium.
- Wet Storage of Fuel - A spent fuel storage option in which the spent fuel is stored in the spent fuel pool without modification to the Spent Fuel Island option.

Four phases have been identified for the decommissioning of a commercial nuclear power plant. Due to varying circumstances, nuclear power plants may be shut down prematurely (i.e., permanent shutdown prior to the end of the original or extended operating license). Detailed site specific analyses are strongly recommended prior to a permanent shutdown decision. These analyses are performed in the first or **Decommissioning Strategy Phase.**

The second phase is the **Organization Transition Phase** in which the site transitions from an operating status and organization to a permanently defueled status which is managed by a shutdown organization staff. Priorities in this phase are the safe shutdown and defueling of the reactor(s), minimizing uncertainty and trauma for personnel, selection and turnover to the shutdown organization, and career transition for employees.

The third phase is the **Facility Transition Phase**. In this phase changes to license requirements, disposition of open work items, and changes to various processes such as work control, engineering/configuration management, security, training, and the emergency plan takes place. In this phase the site may also modify the plant for wet or dry spent fuel storage, and may prepare the site for either the SAFSTOR or DECON decommissioning approach, depending on the outcome of decision analysis for these various decommissioning strategies and fuel storage options.

The fourth phase is **Final Decommissioning Phase** and will be either a SAFSTOR Custodial Phase or Dismantlement Phase, again depending on the decommissioning strategy chosen. If this phase is the SAFSTOR Custodial Phase it will most likely continue until the decommissioning fund for the site is fully funded, at which time the site will go into the Dismantlement Phase. In this phase the site will be dismantled and remediated to either a fully releasable state in which the 10CFR50 license is terminated with all hazards are removed (unrestricted use or “greenfield”), or released for industrial use that may still have radioactivity present (restricted use or “brownfield”).

This report primarily addresses the first three phases of decommissioning focusing on the transition of a facility from operations into a facility entering decommissioning.

The following is a more detailed description of each of these phases and the expected outcomes of each phase. Figure 1-1, following, provides a timeline for regulatory submittals, decommissioning milestones, and use of decommissioning funds.

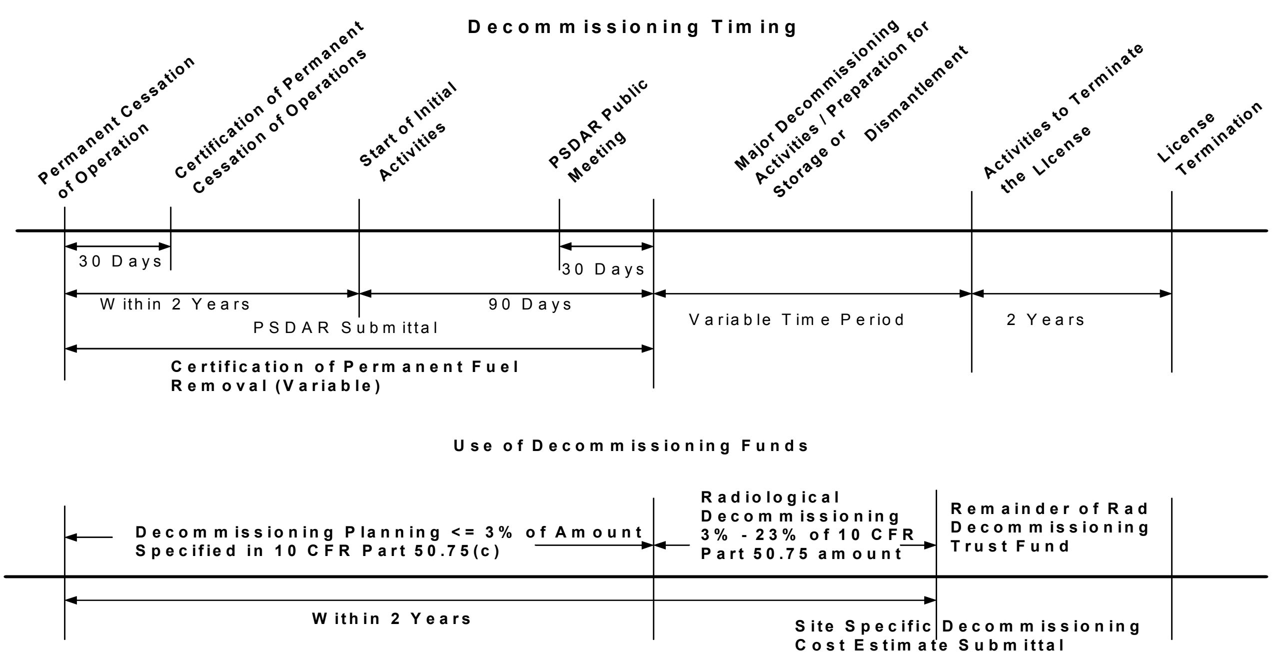

Figure 1-1
Decommissioning Milestones and Use of Funds

Decommissioning Strategy Phase

The activities in this category consist of decision models for key strategic issues that affect the decommissioning methodology needed to reach the final end state of the site. Expected results from this phase include:

- Decision model for determining the decommissioning strategy for the site such as SAFSTOR or DECON;
- Decision model to determine if full system chemical decontamination is warranted; and,
- Decision model for determining the spent fuel storage approach until the fuel is transferred to the Department of Energy.

Many of these activities will begin prior to a decision to permanently shutdown a facility. Some of these activities continue into the Organizational Transition Phase and the Facility Transition Phase as well.

Organization Transition Phase

A transition team should be sent to the site soon after the decision to decommission is made to manage transition activities that include communications, regulatory submittals, augmented oversight activities, human relations, career transition, selection of shutdown/decommissioning organization, and other transition activities. The Transition Team assists the site organization in implementing activities required to transition to a permanent shutdown organization. This allows the current site organization to focus on safe shutdown and defueling of the unit(s). It is essential to recognize that the site organization remains in command and control until formal turnover to a shutdown organization is completed.

If a unit(s) is operating, shutdown will commence after communicating the decision with the operating crews, preparation for unit shutdown is complete, and an independent oversight function is in place. The unit(s) is shutdown separately and defueled separately to reduce the opportunity for error. The current site organization will decide on the shutdown and defuel approach including scheduling, resourcing, and scope.

Employee communications, career transition workshops, trauma management support, and enhanced Employee Assistance Program services should be provided during the Organizational Transition Phase.

The Shutdown Organization Senior Management team should be selected as soon as possible after the shutdown decision announcement. The interview and selection process for the management and employees of the new shutdown organization should be completed on an expedited basis after the senior management team is selected. Generally the shutdown organization will be staffed by site personnel and some individuals with expertise in decommissioning.

As applicable to the affected site, union negotiations will take place for potentially affected union members.

Regulatory submittals for cessation of power operations and certification for permanent removal of fuel from the reactor are made during this timeframe. In addition, on-going communications take place on transition status, issue resolution, and a schedule for license amendments developed with the NRC.

The characterization of open work items on plant systems and a system turnover to engineers in the shutdown organization is completed prior to turnover to the shutdown organization.

Characterization of site hazards (radiological and non-radiological) is initiated with interviews of site personnel including those that will not remain in the Shutdown Organization.

Expected results of this phase are:

- Safe and event-free shutdown and defuel of affected unit(s);
- All stakeholders (internal and external) have been effectively informed of the decision and its potential impacts to minimize uncertainty and trauma;
- Selection of the shutdown organization complete and all other personnel are in career transition;
- Accurate and timely regulatory submittals notifications;
  - Cessation of Operation Notification
  - Certification of Permanently Defueled Condition
- Complete union negotiations (as applicable for the affected site); and,
- Shutdown organization in place with an effective turnover.

The timeframe for this phase is approximately 4 - 6 months for planning purposes, although there is no requirement to complete this phase in 6 months. It is in the best interests of the employees to not prolong this period and allow employees to enter career transition as soon as possible.

Facility Transition Phase

After the Shutdown Organization has taken responsibility for the site, the site focus moves to the following activities. As appropriate, some of these activities may have been initiated in the Organizational Transition Phase:

- Regulatory submittals for changes to license requirements;
- Revision to the UFSAR, and configuration management process;
- Changes to the classification of plant systems;
- Development of detailed project schedules and implementation of appropriate project management processes.

The current UFSAR, Technical Specifications, and procedures will govern facility operations until the changes to these documents have been appropriately reviewed and approved and the appropriate administrative requirements for implementation satisfied.

After changes to the licensing basis are made other processes and programs, such as the Emergency Plan and Security plan, will be evaluated and changes implemented. Other processes such as the Work Control process may continue to be utilized during this phase. Disposition of open work items (modifications, work requests, temporary alterations, operability assessments, etc.) and records will be completed and then an assessment conducted to determine what changes to the Work Control process should be implemented.

The engineering, licensing, and construction activities for any needed plant modifications for the spent fuel storage approach selected takes place in this phase. Also, preparations for dismantlement (DECON) or placing the site in dormancy (SAFSTOR) are completed such as the draining and lay-up of systems, dormant pipe cut and caps, and electrical system de-terminations.

Other activities include investment recovery of assets that are now excess due to the change in facility status. This investment recovery should also include the disposition of new fuel (if any) to recover costs by re-use, de-fabrication, or direct sale.

A Community Advisory Panel (CAP) should be created to provide people in the local community a voice in the decommissioning process and a forum to gather information and provide feedback to the utility. The CAP will most likely consist of local area citizens, school board members, political leaders, and individuals from special interest groups that may be specifically impacted by the unit(s) shutdown. Though the formation of the CAP will begin soon after a shutdown announcement is made, the implementation will take place mostly in this phase.

The transition team that was utilized in the first phase will continue to function in a reduced capacity in support of the Shutdown Organization.

Expected results of this phase are:

- Development and submittal of the Defueled FSAR and Defueled Technical Specifications;
- Development and submittal of the PSDAR;
- Submittal of revisions to the Security Plan;
- Submittal for revisions to the Emergency Plan;
- Characterization of plant systems which includes open work item summary, equipment status, and updates to system documents;
- Development, submittal, and implementation of the Certified Fuel Handler Training program and exemption from 10CFR50.55 requirements for licensed operators;
- Implementation of a revised configuration management process for a decommissioned plant which includes reclassification of systems, revised Master Equipment List, and revised drawings;
- Disposition of open work items and records;

- Completion of training and qualification of personnel in the Shutdown Organization;
- Selection and implementation of a CAP;
- Installation of a dry cask storage system, nuclear island, or long term wet storage of fuel; and,
- Preparation for DECON activities or completion of activities to place the site in SAFSTOR.

Final State Decommissioning Planning

During this period, the facility will either be in a long-term SAFSTOR configuration or in prompt decontamination and dismantlement activities. Dependent upon the path chosen, critical activities may include large project management tasks (e.g., cost, resource, and schedule optimization and management), or long term configuration control and planning for eventual decontamination and dismantlement. The ultimate end state for this phase is the termination of the facility license by the NRC and availability for site reuse in non-licensed activities.

Expected results from this planning phase are:

- Process for final site characterization for radioactive and non-radioactive materials developed;
- License termination requirements developed for final end use of the site;
- Security requirements (if any) for the final end use of the site established;
- Waste disposal management plan implemented that supports the final end use of the site (from SAFSTOR to complete dismantlement); and,
- Project plan for site dismantlement developed that includes dismantlement work packages, schedules, contracts, and budget.

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STRATEGY AND DECISION ANALYSIS

Overview

This report does not specifically consider the decision analysis performed to determine if a power reactor should be prematurely shutdown. Rather it focuses on those actions and activities that are necessary once the decision has been made to permanently end operations. Once this decision has been made, several other key decisions must be made. These decisions include:

- Overall decommissioning approach (DECON, SAFSTOR or other);
- Assessment of need for primary system chemical decontamination; and,
- Determination of spent fuel storage approach

In each of these cases, the decision analysis can generally be reduced to a cost-benefit analysis with stakeholder input considered. The detailed decision analysis approaches are highly company and site specific, so only the overall approaches to each decision analysis are presented.

Overall Decommissioning Approach

The objective of decommissioning is to remove a nuclear or radioactive facility from service and reduce residual radioactivity to a level that permits release of the property for unrestricted use and termination of the license. There are primarily two approaches used for power reactor decommissioning: DECON, SAFSTOR, or a combination of these, e.g., partial decommissioning followed by a storage period prior to completion of decommissioning. These alternatives are detailed in NUREG-0586, Supplement 1 (NRC 2002), and are summarized below.

DECON: The DECON approach involves the removal and decontamination of structures, systems and components to a level that permits termination of the license shortly after cessation of operations.

There are several advantages to using the DECON option of decommissioning. A primary benefit is that the facility and site become available for alternate use in the fastest manner. Another benefit is that the highly knowledgible operating workforce is available to support decommissioning. The availability of low level radioactive waste sites also supports the selection of the DECON approach. The total costs for decommissioning are typically less using the DECON option that the SAFSTOR option, in part due to cost escalation of low level waste disposal. Also, the added costs for surveillance and maintenance during SAFSTOR result in lower DECON costs.

The major disadvantages for the DECON option are the higher work exposures as compared to the SAFSTOR option, and the need for higher levels of available decommissioning funds earlier in the project as compared to the SAFSTOR option.

Typical activities that occur during DECON include:

- Draining of contaminated systems and removal of resins
- System or subsystem chemical decontamination (based on specific business cases)
- Establishment of reduced security controls (smaller vital area)
- Modification of control room
- Initial site characterization and final site survey
- Removal of structures, systems and components
- Decontamination and/or dismantlement of buildings
- Shipment and processing of low level wastes
- Removal of spent fuel and Greater Than Class C (GTCC) wastes and placement in safe interim storage

SAFSTOR: SAFSTOR (safe storage) is the alternative for a nuclear facility to be placed in (or prepared for) a safe, stable condition and maintained in that state for a period of time, followed by subsequent decontamination and dismantlement to levels that permit license termination. Under NRC regulations for a power reactor, the facility may remain in SAFSTOR followed by DECON for up to 60 years.

There are several advantages to using the SAFSTOR option for decommissioning. One key advantage is the reduction in personnel radiation exposure from radioactive decay during the storage period. Exposures to the public are also reduced as compared to the DECON option. As the hazard (radiation levels) are reduced, reductions in the cost of surveillance and maintenance are also possible. The delay in large expenditures for the SAFSTOR option also allow decommissioning funding vehicles (trust funds, etc.) to grow over the storage period.

A disadvantage of SAFSTOR is the reduced availability of personnel familiar with the facility operations at the time of deferred decontamination. When using the SAFSTOR option, it is important to obtain good site historical records in order to mitigate this problem. Another disadvantage is that during the storage period, the facility will require continued maintenance, security and surveillances to be conducted. Lastly, uncertainties regarding the availability and cost of low level waste storage could mean higher overall project costs using this option.

Activities that typically occur during the preparation and storage periods of SAFSTOR include:

<u>During preparation</u>

- Draining of systems and removal of resins
- Spent fuel pool cooling system configuration

- Performance of system or component decontamination and dose reduction activities
- Initial site characterization
- Removal of all existing low level waste
- Removal and shipment or storage of spent fuel (may not be done if fuel is maintained in a spent fuel island)
- Deactivating and deenergizing unneeded plant equipment
- Reconfiguration of plant systems for storage period
- Maintenance of structures, systems and components needed for safe interim storage of fuel and eventual plant dismantlement.

<u>During storage</u>

- Performance of preventive and corrective maintenance on plant structures, systems and components that will be operating or functional during the storage period.
- Maintenance of programs needed for the safe storage of fuel
- Maintenance of security programs
- Maintenance of radiation monitoring and effluent programs
- Processing and disposal of radioactive wastes generated

Following the storage period, the facility is decontaminated and dismantled to levels which permit termination of the license. These activities are the same as described for the DECON option.

Economic Inputs to the Decision Process

Once a decision has been made to enter decommissioning, either through expiration of the NRC issued license, or a premature shutdown, the approach to determine the decommissioning option becomes an economic assessment – similar to many aspects of decommissioning.

Assessment of Need for Primary System Decontamination

Primary system chemical decontamination has been performed at a number of nuclear plants over the past 30 years. Typically, these projects have utilized minimally-invasive reagents designed to lower area radiation exposure rates for operating nuclear plant employees. EPRI has previously presented a number of reports discussing chemical decontamination (EPRI 1999, EPRI 2001b, and EPRI 2004). Typical decontamination factors (DF) of between 3 and 10 have been obtained during previous industry campaigns. In a permanently shutdown plant even higher DF's may be achieved through the use of more aggressive processes.

Internal decontamination of primary and potentially secondary side systems at a shut down nuclear facility proceeds with two different goals. First, full-system decontamination (FSD) serves to reduce radiation exposure to decommissioning workers. Second, a potential for decontamination to free-release levels for certain sub-systems of the primary (and secondary) side exists. New processes and techniques are evolving rapidly in the decontamination arena, moving towards component free release, therefore minimizing total decommissioning low-level waste (LLW) volumes.

The objective of this assessment is to assist those individuals responsible for Radiation Protection and LLW management in the decision-making process regarding the cost-benefit of internal system decontamination. The end points of this assessment are:

- Provide recommendations on whether a primary/secondary system (or sub-system) decontamination is cost beneficial and feasible;
- Determine the scope of decontamination required;
- Identify decontamination methods available; and,
- Determine the effects of decontamination on other decommissioning activities.

The primary goals of system decontamination efforts is to reduce occupational exposures to decommissioning workers and a reduction in the decommissioning schedule. These decontamination feasibility studies must consider the reduction in exposure for decommissioning activities, and balance them against decontamination costs, occupational exposure received during the decontamination process, and handling of secondary waste.

In order to assess the relative benefit to chemical decontamination two radiological parameters must be known. The first, the Decontamination Factor (DF) is the projected or actual radiation field reduction obtained on the component which has been decontaminated. The second factor is the Dose Reduction Factor (DRF), which is the reduction in working dose in a particular area. For example, a pipe with initial exposure rates of 100 mR/hour is decontaminated to a point that the exposure rate is 10 mR/hr. This would be a DF of 10. Due to other sources of radiation or the area configuration, such decontamination may only result in a working area dose reduction from 50 mR/hr to 25 mR/hr or a DRF of 2.

A summation of exposure savings for all system components to be removed must be made. This summation may then be compared, via an ALARA process, to the costs associated with system decontamination. Particular attention should be paid to the following issues:

- Decontamination(s) can be performed on multiple systems, individual systems, or portions of individual systems. The scope of the decontamination(s) should be selected to maximize the DRF obtained.
- Unique system configuration, associated hazardous materials (asbsestos or lead based paint), or physical configuration may require longer than typical dismantlement times. These longer duration tasks may be candidates for dose reduction.
- Decontamination can also be performed not to eliminate hazards, but to reduce them to a level in which personnel protective equipment is reduced. For example, elimination of respiratory protection will significantly increase worker productivity. Dose rate reductions which can be expected to occur due to radioactive decay between the time of shutdown and the time of dismantlement.

- The ability of existing systems to provide flow paths and flow rates required for decontamination need to be addressed, as well as, system condition and operability.
- Modification of existing procedures or the development of new procedures needs to be addressed and costs estimated.
- The requirements for modifications to system hardware need to be identified and costs estimated.

Any decontamination method proposed must be shown to not unacceptably degrade materials of systems required to be Operable or functional, or raise concerns of long-term structural integrity. This may be demonstrated by analysis, in-situ tests, or a combination of the two.

Internal system samples should be taken, as reasonable, to determine the radionuclide mix and the total source term of inner surface contamination. These samples will be useful in evaluating the DFs of various processes. Gamma spectroscopy may also be used to determine the radionuclide mix for gamma emitters.

Estimated decommissioning activity radiation levels should be assembled for both decontamination and non-decontamination scenarios, for each work area of interest for the system. These estimated radiation levels should be adjusted for anticipated radioactive decay prior to dismantlement.

A determination of the person-hours to be spent in decontamination, removal, packaging, shipment, and disposition of radiological and non-radiological material generated during the decommissioning process will be included in this table.

The costs of radiological and non-radiological waste disposition should be generated for both decontaminated and non-decontaminated scenarios. Therefore, a thorough estimate of the secondary dry active, filter media and resin waste volumes must be made to complete the cost-benefit analysis.

The total costs of decommissioning activities should be calculated for both decontaminated and non-decontaminated scenarios. Based upon the person-Rem savings calculated, and the utility cost per person-Rem, a cost-benefit analysis may be completed. The overall analysis is shown in the following worksheet:

Spent Fuel Storage Options

In U.S. power reactors, the long-term management of the spent fuel is based primarily on two options -- wet storage using portions or all of the existing spent fuel pool and dry storage using an on-site Independent Spent Fuel Storage Installation (ISFSI). Both options are currently in use at decommission and operating sites.

If the DECON option is chosen, then the approach essentially mandated by schedule is wet storage in the spent fuel pool or spent fuel island, until the fuel can be offloaded into dry cask storage. Typical dry cask storage system licenses require a minimum of five years of spent fuel decay in spent fuel pools to reduce heat load prior to placement into dry cask storage. This requirement means that the spent fuel pool and anciliary systems are usually required for at least five years after final reactor shutdown.

Further discussion on various spent fuel storage options is provided in EPRI 1999, EPRI 2001, EPRI 2002 and EPRI 2005

Wet Fuel Storage

In virtually all decommissioning scenarios, the spent fuel pool will be used for some period of time after cessation of operations. As noted above in case of a decision to dry cask storage, the spent fuel pool is still required for the requisite decay period to meet the license requirements for the dry cask storage system chosen. After cessation of operations most utilities have chosen to isolate the spent fuel pool into a spent fuel island (SFNI). For this approach, the ancillary services needed for the spent fuel pool system such as cooling, purification, makeup are provided by new separate and smaller systems from those used during operations. This effectively allows the plant operation systems to be deengergized and removed if desired. The development of the SFNI is fairly simple in a pressurized water reactor (PWR) or reactor where the pool is located in an independent structure separate from the reactor. Installation of a SFNI is more difficult when the pool is connected to the reactor cavity.

The benefit to the use of wet storage or a SFNI is the relatively modest initial capital cost. Depending upon the specific SFNI approach selected, these initial modifications may be made for a few million dollars (five million in the example to follow). The economic penalty for the use of wet storage is that the ongoing operating and maintenance costs exceed those for dry storage. Over a period of time, these larger annual costs make the wet storage option, the more costly approach over the life of the project.

Dry Fuel Storage

The selection of a dry cask storage system allows for the optimal implementation of the DECON approach by removal of the fuel from the spent fuel pool in a time frame consistent with the decontamination and dismantlement of the remaining plant structures, systems and components. Once the spent fuel and GTCC materials are in dry cask storage, the greatest percentage of radioactive material has been removed from the facility.

All currently licensed dry cask systems provide for the placement of fuel assemblies within metal racks similar to the spent fuel racks used in the spent fuel pool. These racks are placed within a metal canister, and then are placed within a metal or concrete overpack. This completed canister/overpack is place on concrete pads, typically called an Independent Spent Fuel Storage Installation or ISFSI. The canister/overpacks will remain on site on the ISFSI until the DOE accepts the fuel and removes the canisters/overpacks from site. At this point the ISFSI can itself be decommissioned and actions can be taken to terminate the spent fuel storage facility license.

In this simplified hypothetical example, the chart shows that the dry storage approach incurs higher costs over the wet storage approach in the early part of the project. At approximately 18 years after shutdown however, the lower operating and maintenance costs for the dry storage approach results in lower total costs. If the utility expectation is that the DOE will not take title to the spent fuel for greater than 18 years after shutdown, then dry cask storage would result in the lowest total cost. In practice, this approach is used, taking into account additional economic parameters and operational information.

3
COMMUNICATIONS AND HUMAN RESOURCES

Overview

This section addresses concepts and concerns for the human aspects of a power reactor permanent shutdown. Effective communication to the affected stakeholders of the shutdown is critical from the initial shutdown announcement, and continuing into the license termination phase of decommissioning.

In all transitions from operations into decommissioning, an equally critical need is sound human resources plans and approaches. Clearly, if a utility chooses to outsource much of the decommissioning work, then the human resource need is evident. However, even if the utility chooses to use the incumbent work force for the decommissioning project, the differing skill set needs for decommissioning results in differing, but still essential human resource skills.

Although both of these issues are important for decommissioning success, the fact that they deal with the human element means that they are not readily addressed in standardized approaches. Each facility must be evaluated based on its own particular stakeholder and human resource needs. As such, the following provides more concepts and items to consider in the development of site specific programs for communications and human resources.

Communications

The permanent shutdown of a power reactor is a significant event. Certainly to those employees of the facility it may represent difficult career choices. If the shutdown is premature, it adds additional levels of tension to the workforce. Utility personnel not at the site may question the financial health of the company. Members of the local communities will be concerned about the impact of the shutdown as well for various reasons ranging from questions of facility safety to implications for the local tax base. Rigorous and frequent communications with all affected stakeholders is a key to minimizing employee and other stakeholder concerns.

The needed communications will vary somewhat whether the affected group is the facility staff and other utility personnel not located at the site (Internal Communications) or non-utility personnel (External Communications). One common factor is the need for consistent information to be conveyed as broadly as possible, as soon as possible after a decision on permanent shutdown has been made.

Internal Communications

An efficient internal communications approach is essential in order to maintain morale and continued worker focus on the tasks at hand. Significant work must still occur while plant personnel are wondering, "How does this affect me, how does this affect my job, my family, my relocation options, etc." If the permanent shutdown is planned and announced well in advance, it affords the best opportunity to minimize the trauma of the shutdown. If the shutdown is premature, it adds additional communication challenges.

Once a shutdown decision has been made by appropriate corporate executives, the affected plant senior management should be brought together and briefed on the decision and the near term actions to accomplish. Following the senior management briefings, additional site and utility communications should occur.

External Communications

The permanent shutdown of a power reactor is also a significant event for external stakeholders. The shutdown most significantly affects the local economy as most power reactors provide a significant percentage of property taxes, is a large user of local services and products, and provides employment for several hundred individuals, many of whom live in the local communities.

The economic aspects are addressed further in this report as is the development of a Community Advisory Panel (CAP) which provides a communication vehicle to external stakeholders after the plant transition into decommissioning is occurring. The essential remaining task is communications to affected stakeholders to take place coincident with communications to the site personnel.

Individuals that should be individually notified this would include:

<u>EXAMPLE</u>

- State Governor,
- State and U.S. Representatives and Senators of affected district
- Mayors of affected local communities
- Leaders of affected county governing boards
- Appropriate Union leaders (if the affected plant is staffed with union personnel)

Organizations that should be notified include:

- NRC – Regional and Headquarters
- State Nuclear Regulatory Agency (if applicable)
- State Public Utility Commission
- Federal Energy Regulatory Commission

- Stock or Bond Rating Firms (if utility has publicly traded stock)
- Media

Human Resources

Early in the decommissioning process an evaluation should be made to determine the staffing approach to be used for decommissioning. Typical approaches used in the industry vary based on the decommissioning approach selected. In the SAFSTOR approach, most facilities have retained a small compliment of operational staff during the preparation and storage period, with the bulk of the site staff no longer needed.

In the DECON approach, several staffing methods have been used. One extreme would be for the utility to retain a very small staff to provide an oversight function and the remainder of the staff needed for decommissioning would be provided under contract from one or more vendors. The alternate extreme is for the utility to retain virtually all the operations staff, and obtain only specialists or augmented staff support for limited uses. In most cases however, some level of operating staff reduction occurs. Typically, the project staffing would change throughout active decommissioning, needing fewer staff with operational skills and greater numbers of staff with deconstruction and decontamination skills.

Each staffing approach benefits and weaknesses. Substantial staffing changes also will typically result in substantial stakeholder interaction, as site staff may often reside in local communities. Using existing operating staff provides a number of benefits to the project. Some of these benefits include:

- The staff already maintain site access and security authorization;
- The staff are familiar with site structures, systems and components;
- The staff are familiar with plant procedures and licensing bases; and,
- Using existing staff results in a reduction in overall staff trauma.

Benefits of using contracted staff include:

- Staff may be more familiar with project management methods more typical of decommissioning;
- Aspects of decommissioning relate to one-of-a-kind tasks, such as removal of reactor vessel, making site familiarity less significant;
- Decommissioning requires larger numbers of personnel with craft skills than typical operating staff maintain; and,
- Contracted staff may provide a lower cost staffing option.

These types of programs have been widely used, and reported in other EPRI references (EPRI 1997, EPRI 1998, EPRI 2000, EPRI 2001, EPRI 2005)

4
LICENSING ACTIVITIES

Introduction

This section documents the approach for accomplishing the primary regulatory activities over the first two years after a decision is made to permanently shutdown a nuclear facility.

The objectives are the following:

- Submit the required notifications to the NRC for permanent cessation of operations and fuel removal from the reactor vessels;
- Communicate with the NRC and appropriate state regulatory agencies at specified stages in the deployment of the shutdown decision to keep them informed of progress and future actions;
- Identify pending NRC licensing actions that can be deferred or deleted and disposition them with NRC concurrence;
- Provide guidance to support preparation of a PSDAR for submittal to the NRC; and,
- Identify sources of information for preparing the various sections of a PSDAR;

Near Term Actions

The following actions should take place between the date of final shutdown and approximately three months after the shutdown.

- Prepare a letter for senior nuclear executive signature certifying the permanent cessation of operations and submit the letter to the NRC.
- Periodic meetings with the NRC (Regional and Headquarters) and the appropriate state nuclear regulatory agency need to be held to keep the agencies informed of the status of the plant, as well as planned future activities.
- If not already issued, develop a list of applicable technical specifications for the defueled condition including the necessary technical specification interpretations. This document should be reviewed and approved by the time defueling of the applicable unit(s) is completed.
- Subsequent meetings with NRC and state agencies should address:
  - Present facility status (e.g. defueling in progress, complete, etc.)
  - Progress in transition

  - Discussion of proposed future licensing submittals should also be presented (PSDAR, defueled FSAR, defueled technical specifications).

- Upon completion of defueling the unit(s), prepare a letter for the senior nuclear executive certifying permanent fuel removal from the reactor vessel(s) and submit it to the NRC. The letter must include a "disposition of the fuel" per 10CFR50.4.

PSDAR

Decommissioning activities will be restricted until after the required submittals have been made since only 3% of the NRC generic funding amount may be utilized until 90 days after submittal of the PSDAR. Also, the withdrawal of trust funds is limited to 20% of the NRC generic funding amount until the site-specific decommissioning cost estimate has been submitted.

Work on the PSDAR can begin at any time the required information is available, with submittal required within two years after permanent cessation of operations. Some of the important information and decisions that must be made before a PSDAR can be submitted include:

- Decommissioning Option — SAFSTOR versus DECON
- Fuel Storage Option — Wet versus Dry
- Site Restoration — Greenfield versus 'Brownfield' (restricted access)
- Plant Future Activities — Re-Powering or Complete Dismantlement
- Trust Fund Content Adequacy
- Low Level Waste Disposal Facility Availability

The purposes of the PSDAR are to (1) inform the public of the licensee's planned decommissioning activities, (2) assist in the scheduling of NRC resources necessary for the appropriate oversight activities, (3) ensure the licensee has considered the costs of the planned decommissioning activities and considered the funding for the decommissioning process, and (4) ensure the environmental impacts of the planned decommissioning activities are bounded by those considered in existing environmental impact statements. Copies of previously submitted PSDARs from other sites should be reviewed for reference and information.

The NRC has developed guidance for the preparation of a PSDAR in Regulatory Guide 1.185 (NRC 2000). The following guidance is taken from this reference. The PSDAR is to contain information on four topics:

- Description of Planned Decommissioning Activities
- Schedule of Planned Decommissioning Activities
- Estimate of Decommissioning Costs
- Environmental Impacts
- Radiation Exposure Estimate
- Estimated Volume of Radwaste Expected

Other Decommissioning Options to be Described in the PSDAR

If long-term storage (longer than approximately 5 years) is selected as a decommissioning option, the activities related to preparing the facility and site for storage should be listed and described. Activities and tasks for maintaining the facility and site in safe storage should also be discussed.

The activities related to the transition from long-term storage to decommissioning and activities related to the final decommissioning of the facility should also be described to the extent known. According to 10 CFR 50.82(a)(3), decommissioning will be completed within 60 years of permanent cessation of operation unless a longer term for completion is approved by the NRC as necessary for public health and safety.

Schedule of Planned Decommissioning Activities

The purpose of the schedule is to provide information to the NRC and the public on the anticipated timing of decommissioning events, as well as to allow the NRC to schedule resources necessary for appropriate oversight activities. Schedules or diagrams should clearly indicate the estimated initiation and completion of the major decommissioning activities with potential increased risk to the workers, public, or environment, or those that are unique to the facility. Any activities that will require a significant NRC licensing effort should be identified, including the start and desired end dates for activities such as the submission of defueled technical specifications, the approval and licensing of an ISFSI, the licensing activities associated with a certificate of compliance for transportation of major components, or the approval of the license termination plan.

Estimate of Expected Decommissioning Costs

The PSDAR should include an updated estimate of the expected decommissioning costs. The updated cost estimate required by 10 CFR 50.82(a)(4)(i) may be (1) the amount of decommissioning funds estimated to be required pursuant to 10 CFR 50.75(b) and (c) as currently reported on a calendar-year basis at least once every 2 years to the NRC according to 10 CFR 50.75(f)(1), (2) a site-specific cost estimate that is based on the activities and schedule discussed above, (3) an estimate based on actual costs at similar facilities that have undergone similar decommissioning activities, or (4) a generic cost estimate. The licensee's decision on which type of estimate to include in the PSDAR should be based on specific plans for decommissioning. If a licensee has chosen extended safe storage of the facility followed by decontamination and dismantlement, generic information would be acceptable to the NRC staff as cost estimates of final dismantlement could occur far in the future.

Environmental Impacts

As with any action by the NRC, an assessment of the potential environmental effects is required. The staff prepared the GEIS (NUREG-0586) to address the environmental impacts associated with decommissioning of nuclear facilities in August 1988. The NRC issued Supplement 1 to NUREG-0586 in November of 2002.

The staff guidance indicates that potential impacts should be compared with similar impacts given in the final environmental statement (FES) or generic environmental impact statement (GEIS). If the impacts have already been considered and are bounded by the GEIS, this should be described in the PSDAR. Supporting documentation should be available, but not included in the PSDAR. Potential impacts include radiological and non-radiological examples: occupational dose; environmental releases to air, water and soil and the resulting population doses; quantity of low level waste generated; transportation impacts; impacts from non-radiological hazards such as dust, noise, water use and hazardous waste; impacts to endangered species. If any activities described in the GEIS do not bound the comparable planned decommissioning activities, they should be noted and assessments provided to the NRC that will allow them to evaluate the deviation from previously evaluated activities. In addition, the discrepancy from previously evaluated activities will require submittal of a license amendment that addresses the impacts of the planned activities. If possible, the section should end with a positive summary statement that indicates all planned activities have been previously evaluated and the impact on the environment was determined to be acceptable.

Adequate supporting documentation can be recent and applicable environmental assessments or the FES for the facility. For older facilities this is likely to take the form of some assessment performed during the life of the facility. Newer plants will have explicit FES available.

Other Considerations Regarding the PSDAR

The NRC is required to notice receipt of the PSDAR and make the PSDAR available for public comment. The NRC will also schedule a public meeting in the vicinity of the licensee's facility after receipt of the PSDAR. The NRC will publish a notice in the Federal Register and in a forum, such as local newspapers, that is readily accessible to individuals in the vicinity of the site, announcing the date, time and location of the public meeting, along with a brief description of the purpose of the meeting.

Licensees are not permitted to perform any major decommissioning activities (as defined in 10 CFR 50.2) until 90 days after the NRC has received the PSDAR and until certification of the permanent cessation of operations and permanent removal of fuel from the reactor vessel, as required by 10 CFR 50.82(a)(1), have been submitted.

The PSDAR is a living document. Changes in major milestones, scheduling, resources, or environmental impacts not bounded by the FES or GEIS require written notification to the NRC.

Examples of changes in activities and schedule that would trigger a PSDAR update include:

- Changing from long term storage to active dismantlement, i.e. a change in the method of proposed decommissioning, or
- Changing the method used to remove the reactor vessel or steam generators from cutting/segmenting to intact removal, or changing the schedule to affect major milestones
- Examples of significant cost increases that would trigger an update:
  - New estimated cost > 20% above site-specific or PSDAR cost estimate, or

– 25% increase in cost above a major milestone estimate.

Submittals with PSDAR

In addition to the PSDAR, the NRC regulations require the submittal of two documents related to the decommissioning activities within the first two years following plant shutdown. These reports are a site-specific decommissioning cost study and a description of the program to manage and provide funding for the management of irradiated fuel.

The requirement to submit a site-specific decommissioning cost estimate is from 10 CFR 50.82(a)(8)(iii), which requires:

Within 2 years following permanent cessation of operations, if not already submitted, the licensee shall submit a site-specific decommissioning cost estimate.

The requirement to submit a description of the program to manage and provide funding for the management of irradiated fuel is specified in 10 CFR 50.54(bb) which requires:

_ the licensee shall, within 2 years following permanent cessation of operation of the reactor or 5 years before expiration of the reactor operating license, whichever occurs first, submit written notification to the Commission for its review and preliminary approval of the program by which the licensee intends to manage and provide funding for the management of all irradiated fuel at the reactor following permanent cessation of operation_.

The latest version of these regulations should be consulted to identify the specific applicability and wording of which apply.

Recent NRC activities in this area are described in a paper at Waste Management 2006 Symposium in Tucson, Arizona, titled "NRC Decommissioning Program Rulemaking and Guidance" by J. Shepherd, T. Fredrichs.

USFAR/DSAR and Other Licensing Basis Documents

Defueled Safety Analysis Report Development

The Updated Final Safety Analysis Report (UFSAR) provides a licensing basis document for the evaluation of facility activities under 10 CFR 50.59. This licensing basis will require review and revision to cover the reduced hazard level associated with the facilities defueled status and planned decommissioning activities. Once revised to reflect the decommissioning status of the facility, the UFSAR becomes known as the Defueled Safety Analysis Report (DSAR).

The DSAR shall generally be submitted with the Defueled Technical Specification (D-TS) as a package to the NRC for approval. This will ensure that the DSAR and the D-TS are satisfactory and meet the requirements of the commission prior to implementation.

The DSAR must be updated as dismantlement, or modification, of the facility occurs. However, with the minimal descriptions of systems designated as “RES Abandoned” or “RES Removable” the need to revise the DSAR is reduced. RES is an acronym for “Required Equipment Status” and is addressed in section 7 of this report.

The DSAR is still required to be updated on a 24-month review cycle in accordance with 10CFR50.71(e). However, the review cycle commitment existing when the plant enters decommissioning is required to be completed on schedule, prior to entering the 24 month review cycle authorized for the DSAR.

The DSAR development should be completed in a three step process:

Step 1: Accident Analysis

A detailed accident analysis of the facility following cessation of operations and permanent fuel removal shall be conducted to eliminate accidents that are no longer credible, evaluate decommissioning activities that may introduce new accidents to the facility, and evaluate remaining accidents to reflect the defueled conditions in the facility.

Step 2: Safety Classification

The safety classification of Structures, Systems and Components (SSCs) in Chapter 3 of the UFSAR, should be revised based on the revised accident analyses and the permanently defueled status of the plant .

The definition of the classification of safety related should be clarified to reflect the decommissioning status of the facility and the safe storage of the spent fuel. Specifically, SSC classifications that are solely relied upon during design basis events to ensure integrity of the reactor coolant pressure boundary or capability to shutdown the reactor and maintain it in safe shutdown should be considered for reclassification as nonsafety related.

Step 3: Text Revision

The Defueled Safety Analysis Report shall maintain the basic structure of the UFSAR following review and revision. The major sections and section headings shall be maintained; however, only those sections concerning SSCs that are designated as “RES OPERABLE” require the same level of detail as previously provided by the UFSAR. This minimalistic approach to the DSAR will limit the number of DSAR updates required during decommissioning activities involving SSCs that are no longer safety related.

Defueled Technical Specification Development

The Operational Technical Specification (TS) provides the operational constraints for the facility. The Operational Technical Specification will require review and revision to cover the reduced hazard level associated with the facilities defueled status and planned decommissioning activities. Once revised to reflect the decommissioning status of the facility, the TS becomes known as the Defueled Technical Specifications (D-TS).

5
STAKEHOLDER INTERACTION

Introduction

When reviewing the possibility of closing a nuclear station, consideration should be given to what effect this decision will have on the surrounding communities. Taxes paid to the taxing bodies located in these communities amount to a significant amount of their budgets. For this reason, a decision to close a plant will have a financial impact on these communities. In addition, any decrease in employment rates due to a closure will negatively impact the regional economic health.

To minimize the potential negative impact from a decision to close a nuclear plant and to demonstrate understanding of its role as a corporate citizen, a series of suggested community impact mitigation strategies should be recommended.

The outcome from this section is:

- Review the impact a decrease in real estate taxes will have on the surrounding communities.
- Review long term actions that the utility can take to help off set the negative impact associated with a decrease in tax revenues.
- Consider what impact a closure decision will have on local civic groups that rely on financial contributions from the utility and its employees.
- Establish a community advisory board to discuss issues dealing with the decommissioning process.

This task should begin with a general overview of the economic significance a closure decision has on local economies. It should also attempt to quantify the degree to which the community is prepared for such an event.

Real estate tax payments should be reviewed in detail. A table showing the taxing bodies and the amount of taxes received from the utility should be developed. By working with the County Assessor's office, the percentage of total revenue each taxing body receives from the utility can be determined. The possibility of a phase out period for writing down the assessed valuation of the plant should be addressed. The amount of this write down and the timeline for the phase out should be recommended by appropriate company executives and/or officers.

Economic development should be considered in any decision to close a nuclear plant. Consideration should be given to increasing the amount contributed to local economic development councils as well as helping with a long term solution. An example of the later would be helping to attract new industry to the area in an effort to off set any decrease in taxes resulting from a closure decision.

Consideration should be given to the local civic groups that receive financial help from the employees that work at the facility. To help lessen the impact of a decrease in contributions due to a down sizing in employment, consideration could be given to increasing the corporate contribution during a given phase-out period. In addition, vacated facilities could be contributed to the communities for their use.

A group of opinion leaders from the surrounding communities should be established to assist in identifying issues dealing with the closure of the facility. The purpose of this group would be to provide a formal channel of community feedback to the utility on issues relevant to plant operations, decommissioning, and the timeline of various activities pertinent to the closure decision. This group would include State, County and Local elected officials. Also included could be members of the business, education, civic and charitable organizations. A recommendation of individuals by title is given below:

Advisory Council

- Local Mayor(s)
- State Senator
- State Representative
- Chamber of Commerce President
- School Board Superintendent
- Township Supervisor(s)
- Park District Director
- Librarian
- County Administrator
- County Economic Development Director
- Utility Public Affairs Representative
- Utility Economic Development Representative

A list should be established for those individuals that should be notified in case of a decision to close a facility. Notification of these individuals should be done prior to public announcement of the decision to close the plant. This list should include the constituents' phone number and the designated person that should be making the contact. Depending on the facility, the list could include State, County and local elected officials, as well as members of the various taxing bodies. The timing for contacting these individuals will be determined on a site specific basis.

6 ENGINEERING

Overview

An early critical task in decommissioning planning is the reassessment of plant systems in terms of evaluating their safety significance relative to the permanent shutdown and decommissioning condition. This section addresses this initial evaluation and provides an initial listing of systems likely needed for continuing operations. Also addressed are considerations for system retirements, for those systems no longer necessary. Lastly, typical plant modifications needed for various decommissioning approaches are discussed.

Defueled SSC Safety Classifications

There are three Defueled SSC Safety Classifications: Safety Related (SR), Augmented Quality (AQ) and Non Safety Related (NSR). A detailed description of the criteria for each of these classifications is as follows:

- Safety Related (SR) - Safety Related SSC are those relied upon during or following design basis accidents to assure the capability to prevent or mitigate the consequences of accidents that could result in the potential offsite exposure comparable to the guideline exposure of 10 CFR 100.11. There is no specific intent or requirement to "upgrade" SSCs to be Safety Related.
- Augmented Quality (AQ) - Augmented Quality is an optional subset of the classification category of non-safety related. It refers to those items that are not SR but are subject to requirements imposed by the NRC or the utility. SSCs related to the following should be evaluated for classification as AQ.
  - Fire Protection System
  - Radioactive Waste Management System
  - Station Black Out
  - Spent Fuel Cooling
  - ALARA
  - Environmental Qualification
  - Seismic Qualification
- Non Safety Related (NSR) - The NSR classification applies to all items that are not classified as SR or AQ.

Required Equipment Status (RES)

Once the decommissioning strategy has been identified, and the decommissioning options selected, the RES designations must be reviewed periodically and revised as necessary to reflect the decommissioning strategy of the facility and the configuration of the facility during decommissioning.

The definitions of the RES options are addressed following:

Operable

This designation includes any SSC that is required to be maintained fully "Operable" in the operating technical specification definition because it is either required to support the safe storage of nuclear fuel; required for the defueled mode by the Technical Specifications or Administrative Technical Requirements or; Supports the Safe Storage of Nuclear Fuel as a protective, auxiliary, or support system.

A simplified approach may be taken to initially determine those SSCs required to be Operable as shown below.

Table 6-1
Criteria for Selection of "Operable" SSCs

		YES	NO
1	Does the SSC directly ensure spent fuel		
	• Reactivity Control?	☐	☐
	• Cooling?	☐	☐
	• Shielding?	☐	☐
	• Protection?	☐	☐
	• Handling?	☐	☐
	• Storage?	☐	☐
2	Is the SSC required "Operable" by the Plant Technical Specifications or Administrative Technical Requirements?	☐	☐
3	Does the SSC support the operation of SSCs required to provide spent fuel cooling, shielding, protection, handling, and storage?	☐	☐
4	Is the SSC credited to prevent or mitigate the consequences of a spent fuel storage handling or other type of design basis accident for a defueled plant?	☐	☐
5	Does the SSC provide active or passive protection for personnel in the event of an accident or release of radioactive materials (such as from fuel or radwaste)?	☐	☐
6	Does the SSC passively provide support to SSCs required to cool, shield, and protect spent fuel?	☐	☐
7	Does the failure of a SSC interconnected with an "Operable" SSC, without an intervening "Boundary" SSC, cause degradation in the "Operable" SSC?	☐	☐

If any of the answers are "YES," the SSC should be specified as RES "Operable"

Functional

This designation is for SSC(s) that are not required to be "Operable", but must be maintained "Functional" to support general site requirements such as facility habitability, water inventories and/or transfers, radioactive waste functions, or system capabilities that are not yet suitable for termination.

Boundary

This designation is to identify any SSC that can function as a boundary isolation point.

Lay Up

Equipment and systems that need not be operational during SAFSTOR; but will be required to be operational when the facility exits SAFSTOR.

Not Required – Removable

SSCs that are "not required" and may be immediately dismantled and physically removed from the facility.

Not Required – Abandoned

SSCs that are "not required" but can not be independently removed from the facility due to interference or structural concerns.

System Characterization

System Characterization consists of the capture of critical system knowledge including the current status of the system prior to the existing System Engineering staff leaving the site or being reassigned. This additional information will be added to the System Notebooks. The focus will be on "Operable" and "Functional" systems. System Characterization will also be performed on "Not Required" systems, however this effort will be limited to compiling existing, easily retrievable information.

Work shall generally be prioritized with "Operable" systems generally having the highest priority, followed by "Functional" systems and "Not Required" systems having the lowest priority. This consideration shall be made for each System Engineer's assignments based on involvement with supporting plant shutdown and defueling activities.

The following tables provide a typical listing of systems in both PWRs and BWRs that will be categorized as RES Operable.

Table 6-2
Typical BWR Systems Required to be Operable

System Name
Control Room Annunciators
Aux Power
Area Radiation Monitoring
Station Batteries (all)
Diesel Gen & Aux
Fuel Pool Cooling & Cleanup
Fire Protection
Station Cranes
Instrument Air
Process Rad Monitoring
Residual Heat Removal
Main Control Room Ventilation
EDG Room Ventilation
Standby Gas Treatment
Reactor Bldg Ventilation
Tech Support Center Ventilation
Radwaste Ventilation
EDG Switchgear Ventilation
CSCS Equip Cooling
Rx Bldg Closed Cooling Wtr.
Service Water

Table 6-3
Typical PWR Systems Required to be Operable

System Name
Auxiliary AC Power
Station Batteries, DC power (all)
Diesel Generator
Diesel Fuel Oil
Spent Fuel Pool Cooling and Cleanup
Fire Protection, CO2, Halon
Instrument Air
HVAC System Radiation Monitoring
Control Room HVAC
Service Air
Spent Fuel Pit
Computer room, service Bldg. and Control Room Chillers
Service Water
Turbine Bldg Ventilation and DG Building Ventilation

The determination of those SSCs to be categorized as Operable, Functional, and Boundary are fairly straight forward, however the determination of those categorized as Lay Up, or Not Required – Removable is less so.

"RES Lay Up" Evaluation

The "RES Lay Up" Evaluation is only required for those facilities that are entering SAFSTOR. Facilities planning to perform Prompt D&D should not generally place SSCs in Lay Up. A system-by-system evaluation shall be conducted to determine which, if any, SSCs should be placed in a "Lay Up" mode for operation following the SAFSTOR period.

Equipment and systems that need not be operational during the SAFSTOR period; but will be required to be operational to support D&D following the SAFSTOR period should be placed in a "Lay Up" mode.

The following questions are provided to assist in determining which SSCs may be designated as "RES Lay Up".

- Will the SSC be required during the SAFSTOR period? – If “YES”; then the SSC does not meet the requirements for an “RES Lay Up” designation.
- Will the SSC be required following the SAFSTOR period? – If “No”; then the SSC does not meet the requirements for an “RES Lay Up” designation.
- Can the SSC be more effectively replaced following the SAFSTOR period rather than placing the existing SSC in Lay Up? – If “YES”; then the SSC does not meet the requirements for an “RES Lay Up” designation.

“RES Removable” Evaluation

A system-by-system evaluation shall be conducted to determine which, if any, SSCs should be designated as “RES Removable” for unrestricted dismantlement.

The “RES Removable” evaluation shall be conducted using the following criteria. If the SSC meets all of the screening criteria for immediate removal the SSC shall be designated as “RES Removable”. SSCs that fail to meet the screening criteria for “RES Removable” shall be designated as “RES Abandoned” and will require future re-screening or further evaluation and more detailed work instructions prior to dismantlement.

Engineering shall generate general guidelines for designating SSCs as “RES Removable”. The following guidelines consider the different aspects of the SSC to determine if the SSC may be designated as “RES Removable”. SSCs that do not meet the requirements of the “RES Removable” Screening are designated as “RES Abandoned”. “RES Abandoned” SSCs may be re-screened whenever plant conditions change in such a way that the RES designation may be downgraded to “RES Removable”.

Electrical

SSC has been electrically de-energized. This may include physical disconnection or electrical isolation. Electrical isolation may be accomplished by opening disconnects, opening a breaker, or removing fuses. An electrical controller shall not be considered an isolation point unless the cubical has been isolated by opening the breaker or opening the disconnect.

Mechanical

SSC has been mechanically de-energized. This may include draining, venting, or depressurizing the piping, components, and vessels within the SSC. Designation as “RES Removable” requires that the SSC being screened be physically disconnected from all “RES Operable”, “RES Functional and “RES Lay Up” SSCs. Physical disconnection ensures that during the removal of the SSC there are no concerns related to the safety of the spent fuel.

Structural

SSC is not integral to the structure of the building it resides in and is not a structural support to SSC which are not being screened for the “RES Removable” designation. In addition, the SSC shall not pose a threat to the structural stability of surrounding SSCs while it is being removed.

Spent Fuel Safety

SSC must be capable of being removed, without specific instructions, and without endangering the safety of the spent fuel being stored on site. If a removal pathway exists that could endanger the spent fuel, then the SSC shall not be designated as “RES Removable”.

Radiological Hazards

SSC does not present an unusual radiological hazard, either prior to removal activities or during removal activities. SSCs that represent a radiological hazard shall not be designated as “RES Removable”.

Non Radiological Hazards

SSC does not present a non-radiological hazard either prior to removal activities or during removal activities. Non Radiological hazards such as asbestos lead, PCBs, etc. shall be considered during the screening. SSCs that represent a non-radiological hazard shall not be designated as “RES Removable”.

System Retirement Considerations

DRAINING AND LAY-UP OF SYSTEMS: Adequate draining of those systems which have been classified as suitable for abandonment, or partial isolation and draining of Operable systems will be performed to ensure the following:

- The systems can be dismantled at some later date without additional draining.
- Radioactive fluids are adequately drained to prevent future radioactive spills of contaminated fluids and isolated and tagged to prevent airborne contamination which may result from drying out of the system.
- Fluids are removed from system piping to prevent corrosion which could result from undrained and oxygenated water in the pipes.
- Fluids are removed from systems that could not withstand damage from freezing events when areas are no longer adequately heated.
- Fluids and gases are drained/vented to ensure no pressure transients could occur when dismantlement is started.

- Hazardous (acids or caustics) or flammable liquids (oils) or gases (hydrogen) are removed from systems and adequately flushed to ensure no potential dangers remain for future dismantlement.
- System P&IDs will be marked up with the drained piping, components and draining boundaries.

ELECTRICAL DIS-CONNECTIONS: Adequate electrical isolation and determination of systems components which have been classified as suitable for abandonment will be performed to ensure the following:

- Large components which will never be used and whose electrical connections pose a threat to any drained system, such as Condensate Pump Motors, Reactor Coolant Pump Motors (Recirc Pump Motors), including all control and instrument wiring should initially have the breaker opened and racked out. The component should then be determinated at the source and conductors cut back to the panel entry point or taped and tagged to prevent accidental contact with energized components as part of the decommissioning process.
  Electrical isolation should be done on a systematic approach to ensure all required components of that system are isolated. This would include:
  – Pump Motors and Control Power
  – Valve Operator Motors and Control Power
  – System instrumentation and Control Room panel instrumentation, indications, alarms, etc.
  – System interties/interlocks with other systems (Extraction Steam valves with Turbine Control)
- Isolating components by removing all components of a 480 V MCC or 4KV bus will not ensure total isolation for instrumentation, control power, etc.
- All controlled drawings marked up to show the status of the electrical isolation.

CUT AND CAPPING OF PIPING: Cutting and capping may be required on some systems to perform the following:

- Isolation within a certain boundary without isolation of the rest of the system. Such an isolation of one building so that heat can be safely removed without danger of freezing any components.
- Partial systems isolation with cut and caps to keep only those components required for safe storage of fuel in Operation. Example: Reactor Building Closed Cooling Water System – maintaining Spent Fuel Cooling, while isolating and capping all other non-required systems.

RADIOLOGICAL AND SAFETY STANDARDS: All existing Station Radiological and Safety procedures will be followed, as required and established by 10 CFR 20, Technical Specifications, and Industrial Safety Standards while performing all decommissioning activities. This would include the following activities:

- Draining and initial decontamination of radioactively contaminated systems.

- Draining, venting, and flushing of hazardous or flammable liquids/gases, such as Boric Acid, Hydrogen Addition, etc., systems.
- Removal of contaminated / non-contaminated Asbestos piping and component insulation.
- Removal of components containing mercury or PCBs.

STRUCTURAL DEMOLITION REQUIREMENTS: Some structures, not required to support SSCs related to safe storage of fuel or for decommissioning activities may be reviewed for potential demolition.

- Some structures may also require additional review for added Structural Integrity Surveillance Programs if not already being performed.

Any activities of this sort will be reviewed per 10 CFR 50.82, Decommissioning Impact Evaluations, for the impact on decommissioning costs.

Plant Modifications

The following section provides various types of modifications that should be considered for implementation at various stages of decommissioning and dismantlement (D&D). The rationale and the benefits for each proposed modification are also provided.

These modification recommendations cover the various stages of decommissioning, depending on which decommissioning strategy has been selected. These recommendations would also include suggested modifications needed for Systems, Structures or Components required to support the safe storage of Spent Nuclear Fuel utilizing one of the following concepts:

- Dry Fuel Storage
- Wet Fuel Storage
- Nuclear Island Fuel Storage

The following modification recommendations cover the various stages of decommissioning, depending on which strategy has been selected for the Station. These modification suggestions can be applied for both PWR and BWR permanently shutdown and defueled plants, as applicable.

NOTE: The Demolition of a Site would require the use of the same type of temporary equipment, power supplies, cranes, etc., as originally used in the construction phase, only in the reverse path.

If Prompt Dismantlement has been selected, then the following Modifications may be required:

- The “Nuclear Island” method for the spent fuel pool isolation may be selected. See the Nuclear Island section below.
- System isolation modifications and system venting and draining should be considered.

- Removal of hazardous system contents, such as acid and caustic, lube oil and fuel oil, and flammable substances such as found in hydrogen and other gas systems should be considered.
- Modifications to allow access for the removal of hazardous waste such as asbestos, lead, PCB's or any other material considered hazardous may be required.
- Removal of large system and structural components such as turbine generator components, Reactor Vessels, Steam Generators, Pressurizers, etc. may require the following:
  - Additional cranes to remove and place these types of components on shipping vehicles. The Turbine Building/Reactor Building/Containment Building Cranes may not be capable of moving these components beyond the boundaries of the building and these may not reach applicable shipping vehicles.
  - Upgrade of power supplies or portable power supplies to support these crane upgrades. Station power supplies may not have the capacity or may not be connected to these cranes.
  - Upgrading of lifting capability of some existing cranes or components, which may not, by design, be capable of lifting the loads required.
- Provisions for staging areas for equipment removal/shipping and contamination control will need to be set up to control/prevent spread of contamination, control of reusable/saleable equipment, and equipment that is considered scrap.
- Removal of permanent power supplies and heating systems may require the following:
  - Temporary power supplies installed to support removal of permanent electrical components and power supplies during building dismantlements. This would provide power for lighting and tools.
  - Temporary power supplies to support equipment used for dismantlement of systems, components, permanent power supplies, and buildings.
  - Temporary power supplies to supply heating after dismantlement of permanent heating systems and heating system components, power supplies, and buildings.
  - Perform a Site Blackout by providing temporary power with specially marked cables and power supplies, followed by complete de-energization of the site permanent power supplies. Then perform complete removal of the permanent power along with the equipment. This has been found, by industry experience, to be the most effective and safe method of equipment and structure demolition.

If Limited Dismantlement has been selected, then the following modifications will be required as the site progresses with the Decommissioning and at the proper stage:

- Initial modification to provide for minor decontamination removal and modifications to buildings/areas to support future demolitions.
- System isolation modifications and system venting and draining should be considered.
- Removal of hazardous system contents, such as acid and caustic, lube oil and fuel oil, and flammable substances such as found in hydrogen and other gas systems should be considered.

- Placement of the spent fuel into the selected mode of Dry Fuel Storage OR Wet Fuel Storage will require numerous modifications per the Wet or Dry Fuel Storage section of this procedure.
- Selection of the "Nuclear Island" will require modifications per the Nuclear Island section of this procedure.
- Limited dismantlement will require the modifications to support power supplies, cranes, etc. as outlined in the Immediate Dismantlement section, only under limited requirements as the dismantlement is undertaken.
- Modifications for the removal of hazardous waste such as asbestos, lead, PCB's or any other material considered hazardous may be required.

If the Delayed Dismantlement has been selected, then the following modifications may also be required as the site progresses with the Decommissioning and at the proper stage.

- Initial Modification to provide for minor decontamination removal and modifications to buildings/areas to support future demolitions.
- System isolation modifications and system venting and draining should be considered.
- Removal of hazardous system contents, such as acid and caustic, lube oil and fuel oil, and flammable substances such as found in hydrogen and other gas systems should be considered.
- Placement of the spent fuel into the selected mode of Dry Fuel Storage OR Wet Fuel Storage will require numerous modifications per the Wet or Dry Fuel Storage section of this procedure.
- Selection of the "Nuclear Island" will require modifications per the Nuclear Island section of this procedure.
- Delayed dismantlement will require the modifications to support power supplies, cranes, etc. as outlined in the Immediate Dismantlement section, only under limited requirements as the dismantlement is undertaken.
- Modifications for the removal of hazardous waste such as asbestos, lead, PCB's or any other material considered hazardous may be required.

If Dry Fuel Storage has been selected, then the following modifications may be required:

- The ISFSI Pad will have to be designed and built to support the Dry Fuel Storage Cask per the requirements of the Dry Cask Vendor Safety Analysis Report (SAR).
- A ISFSI Cask Transporter will have to be bought, leased or shared with some other plant. At the completion of a Dry Fuel Storage project at a site, the Transporter may be turned over to another site for its Dry Cask Storage Project.
- Cask Cranes (in Fuel Handling/Refuel Area) may need to be upgraded or new cranes built to handle the additional load presented by the storage casks.

- Cask loading auxiliary equipment and systems will have to be ordered and built or existing areas refurbished to handle the storage cask. (Cask drying, decon, inerting, seal welding, laydown and decontamination areas, etc.)
- Fuel handling equipment may have to be modified and or rebuilt to handle fuel associated with Dry Cask Storage
- Security System and lighting modifications will be required to support the Dry Fuel Storage area.
- Spent Fuel Storage Building electrical supplies/support systems may have to be upgraded or added, including independent power supplies if the site auxiliary power supplies are being decommissioned.

If Wet Fuel Storage has been selected, then the following modifications may be required:

- Spent Fuel Pool Cooling System may have to be upgraded to handle a full core off-load. Some plants (BWR) currently use Shutdown Cooling to handle the additional full core off-load into the Spent Fuel Pool, although the fuel decay time allowed by Decommissioning Mode may make this modification unnecessary.
- Reactor Building Cooling Water System should be modified to support only the systems directly affecting the storage of spent fuel. The additional auxiliary loads should be isolated, cut and capped. (See DP – 606, System Retirement Work Packages, for additional information on System Cuts and Caps).
- Service Water / Essential Service Water should be modified to support only the systems directly affecting the storage of spent fuel. (Again, see DP – 606).
- Spent Fuel Building Ventilation System and exhaust path may have to be modified to support site decommissioning by adding a separate or modified monitored release path if the normal ventilation chimney or exhaust stack is removed.
- Spent Fuel Pool structure and monitoring systems upgraded/changed to support spent fuel storage only. (Remove any other components not related to the storage of the fuel, like transfer canal upenders, new fuel elevators, etc.)
- Electrical Support Systems used to power the fuel storage structure, systems and components may have to be modified to support additional systems, if all support systems are moved to the fuel storage area. An independent power supply may be required to support site demolition of Auxiliary Transformers.
- Control room operations, monitoring and alarms may be modified to primarily support the storage of spent fuel and the required electrical, ventilation, and auxiliary systems. All other systems can be removed, retired or placed in SAFSTOR.

The Spent Fuel building may be converted into a Nuclear Island during or before the Immediate Dismantlement by processing the following modifications, where the Spent Fuel Building would or could stand alone and demolition of the rest of the site now performed.

- Spent Fuel Pool Cooling System modified to stand alone in the Spent Fuel Building. This may require a new cooling source to the Spent Fuel Heat Exchangers or the addition of an air cooled Fuel Pool Cooling System, if the plant RBCCW or Service Water Systems are retired.

- Reactor Building Cooling Water System modified or moved to the Fuel Building to support the Spent Fuel Pool Cooling System. The remaining auxiliary support systems formerly cooled by the RBCCW should be cut and capped.
- Service Water / Essential Service Water system modified to support only the systems directly affecting the storage of spent fuel, such as Fuel Building Ventilation and Reactor Building Closed Cooling Water needs.
- Spent Fuel Building Ventilation System and exhaust path modified to support the Island approach by adding a separate or modified monitored release path due to the normal ventilation chimney or exhaust stack being removed.
- Electrical Support Systems modified to provide an independent power supply to support the Island. This would allow electrical isolation and demolition of the rest of the site with minimum interference to the Fuel Storage area.

Control Panel for systems operations, electrical power supplies, fuel storage monitoring and system alarms to support the storage of the spent fuel relocated to the Fuel Building. This would allow demolition, retirement or SAFSTOR for the Main Control Room and panels.

7
SITE CHARACTERIZATION

This section documents the approach for initial site characterization of a site following a decision to permanently shutdown a nuclear facility. It provides instructions and direction to allow for the initial evaluation of existent hazards (radiological and non-radiological) including any requisite sampling approaches necessary. Much of this material is derived from NUREG 1575 (MARSSIM)

The overall approach is shown in the figure below

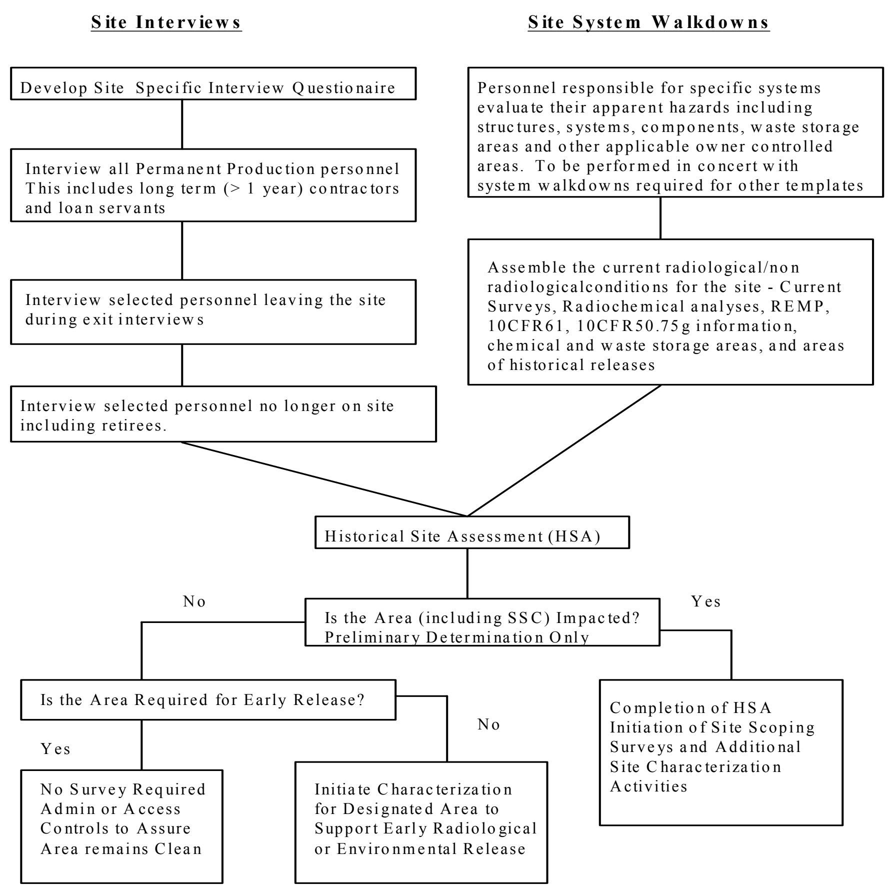

Figure 7-1
Overview of Initial Characterization Process

All site characterization activities should be targeted to confirm that the site ultimately meets the radiological release criteria specified in the NRC Final Rule on Radiological Criteria for License Termination, as well as the EPA objectives for the facilities future use.

The primary Organizational Transition Phase activity will be the initiation of the Historical Site Assessment (HSA), evaluation of the data obtained, and the initial determination of affected and unaffected areas of the plant for further characterization work.

Historical Site Assessment

The Historical Site Assessment (HSA) is the first step in the Radiation Survey and Site Investigation Process. The HSA is a detailed investigation to collect existing information (from the start of site activities related to radionuclides) for the site and its surroundings.

The HSA:

- Identifies potential, likely, or known sources of radioactive material, radioactive contamination, or chemical contaminants based on existing or derived information
- Identifies sites that may need further action from those that pose little or no threat to human health
- Identifies ecologically sensitive habitats or endangered species that may require consideration during the decommissioning process.
- Provides an assessment for the likelihood of contaminant migration
- Provides information useful to subsequent scoping and characterization surveys
- Provides initial classification of the site(s) or survey unit(s) as non-impacted or impacted, along with the site(s) or survey unit(s) impact class.
- Identifies permits that may require modification during the decommissioning process.

The HSA may provide information needed to calculate derived concentration guideline levels (DCGLs) and furthermore provide information that reveals the magnitude of a site's DCGLs. Chemical constituents may be initially compared to the EPA "Soil Remediation Objectives for Industrial Commercial Properties" and either the Class I or Class II standard for groundwater as appropriate. This information is used—for comparing historical data to potential DCGLs—to determine the suitability of the existing data as part of the assessment of the site.

Detailed guidance on performing a historical site assessment are provided in EPRI Report 1009410 titled "Capturing Historical Knowledge for Decommissioning of Nuclear Power Plants – Summary of Historical Site Assessments at Eight Decommissioning Plants", published in 2004.

8 REFERENCES

The following references were either used in the development of this lessons learned document or are provided as additional background information for the reader. Many of these documents are available in electronic format via the internet. The applicable URL is provided in these cases. All the EPRI documents listed are available for download from the member website if the reader's utility has subscribed to the appropriate EPRI service line. In some cases, the reference documents were available through the USNRC ADAMS system.

EPRI Documents

TP-114403	12/99	Guidelines for Fabrication, Examination, Testing and Oversight of spent nuclear fuel dry storage systems
TR-106148	2/96	Shoreham Decommissioning: Project Summary and Lessons Learned
TR-107331	12/99	DAW and Mixed LLW Processing and Volume Reduction Techniques
TR-107707	2/98	EPRI DFD Decontamination for Decommissioning Process Evaluation
TR-107916	9/97	Trojan PWR Decommissioning Large Component Removal Project
TR-107917-V1	12/97	Yankee Rowe Decommissioning Experience Record, volume 1
TR-107917-V2	12/98	Yankee Rowe Decommissioning Experience Record, volume 2
TR-107957	9/99	Carbon-14 in Low Level Waste
TR-107977	11/99	Cost/Performance Evaluation of Advanced Low Level Waste (LLW)
TR-107979	1/98	Fort St. Vrain Decommissioning: Final Site Radiation Survey – Summary Report and Lessons Learned
TR-109030	1/98	Fort St. Vrain Decommissioning: Public Relations and Human Resource Issues – Personnel Plans and Communications During Decommissioning of Nuclear Power Plants
TR-109031	12/97	Trojan Nuclear Plant – Final Survey Report for the ISFSI Site

TR-109032	3/98	Regulatory Process for Decommissioning Nuclear Power Reactors
TR-109035	9/98	A Mobile High Resolution Gamma Ray Spectrometer System for Radiological Surveys
TR-109036	12/98	Review of Experience with the EPRI DFD Process
TR-109448	4/99	Utility Use of Constant Scaling Factors
TR-109449	12/98	Cost Reduction Strategies for Mixed Waste
TR-109460	11/99	Decommissioning Standard Review Plans and Risk-Informing Decommissioning Regulation
TR-110006	1/98	Proceedings: EPRI/NEI Decommissioning Workshop – San Antonio, TX 12/97
TR-110089	3/99	Experience Based Interview Process for Power Plant Management
TR-110234	9/99	Decommissioning Low Level Waste Management and Reduction Guide
TR-111025	1/99	Proceedings: EPRI/NEI Decommissioning Workshop – Monterey, CA 12/98
TR-111277	5/99	Proceedings: Embedded Pipe Decontamination Technology Workshop
TR-112054	7/99	Determination of the Accuracy of Utility Spent-Fuel Burnup Records
TR-112092	1/99	Evaluation of the Decontamination of the Reactor Coolant Systems at Maine Yankee and Connecticut Yankee
TR-112143	10/99	Methodology for Decommissioning Project Management: Trojan Nuclear Plant Decommissioning Experience
TR-112351	3/99	Spent Fuel Pool Cooling and Cleanup During Decommissioning: Experience at Trojan Nuclear Power Plant
TR-112352	7/99	Decontamination Handbook
TR-112871	2/02	Decommissioning: License Termination and Final Site Release: Proceedings of an EPRI workshop 10/2001
TR-112874	11/99	Comparison of Decommissioning Dose Modeling Codes for Nuclear Plant Use: RESRAD and DandD
TR-112875	12/99	Proceedings: Hazardous Waste Material Remediation Technology Workshop
TR-112876	8/99	Proceedings: Site Characterization and Final Release Technology Workshop – Toms River, NJ 12/99

TR-112877	11/99	Experience in the Testing and Application of the EPRI DFD Process
TR-112920	3/00	Radwaste Desk Reference
TR-112992	9/99	Optimizing Site-Specific ALARA Assessments
TR-113530	9/99	Cold Demonstration of a Spent Nuclear Fuel Dry Transfer System
TR-114742	3/00	NP/LOMI Decontamination of the Laguna Verde-2 BWR
TR-114751	2/00	Improved Cobalt Removal: Compendium of Experience in Radioactive Cobalt Removal from Liquid Streams
1000093	6/00	Preparing for Decommissioning: The Oyster Creek Experience
1000157	6/00	Dry Cask Storage Project – Interim Report
1000698	9/00	Guidelines for Fabrication, Examination, Testing and Oversight of Spent Nuclear Fuel Dry Cask Storage Systems (R1 of TP-114403)
1000884	12/00	Decontamination Technology Experience Reports
1000892	11/00	Decommissioning Regulatory Process Interactions in 2000 – EPRI Support to NEI for the NRC Proposed Decommissioning Rule Revision
1000951	11/00	Embedded Pipe Dose Calculation Model
1001030	11/00	Decommissioning Pre-Planning Manual – Interim Report
1001238	1/01	Proceedings: Decommissioning – Plant Reconfiguration & Engineering Processes Workshop
1001321	3/01	Trojan Spent Fuel Pool Chemistry Control During Fuel Transfer to Storage Pool
1002438	12/03	Vibratory Sheer Enhanced Process Filtration for Processing Decontamination Wastes at Rancho Seco
1002761	12/03	A Review of Ultra-filtration for Liquid Radioactive Waste Processing Systems
1002763	10/02	Interim Storage of Low and Intermediate Level Wastes: Guidelines for Extended Storage
1002822	11/03	Guidelines for the Optimization of Protective Clothing
1002882	9/02	Dry Cask Storage Characterization Report – Final Report
1002896	12/02	Capturing and Using High-Value Undocumented Knowledge in the Nuclear Industry – Guidelines and Methods

1003010	10/01	Dry Cask Storage Characterization Project – Interim Report
1003011	3/02	Dry Cask Storage Probability Risk Assessment Scoping Study
1003025	11/01	Decommissioning Pre-Planning Manual – Final Report
1003026	11/01	Decontamination of Reactor Systems and Containment Components for Disposal or Refurbishment
1003027	11/01	Interim Storage of Greater Than Class C Low Level Waste
1003029	10/01	Decommissioning: Reactor Pressure Vessel Segmentation
1003030	11/01	Determining Background Levels in Support of Decommissioning of Nuclear Power Plants
1003126	11/01	Program Considerations for Addressing Alpha Emitting Radionuclides at Nuclear Power Plants
1003196	6/02	Guide to Assessing Radiological Elements for License Termination of Nuclear Power Plants
1003416	12/02	Technical Bases for Extended Dry Storage of Spent Nuclear Fuel
1003423	4/02	Trojan Nuclear Plant License Termination Plan Development Project
1003424	5/02	Spent Fuel Pool Cooling and Cleanup Systems – Experience at Decommissioning Plants
1003425	10/02	Development of the EPRI DFDX Chemical Decontamination Process
1003426	10/02	Summary of License Termination Plans Submitted by Three Nuclear Power Plants
1003436	11/03	Advanced Volume Reduction and Waste Segregation Strategies for Low Level Waste Disposal
1003686	12/03	Effective Personnel Exposure Control in Shortened Refueling Outages: Final Report – Review of Remote Monitoring Systems
1004663	3/02	Guidelines for Capturing Valuable Undocumented Knowledge from Energy Industry Personnel
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1008017	12/03	Operational Changes and Impacts on LLW Scaling Factors
1008018	11/03	Radiological Characterization for Reactor Pressure Vessel and Internals Enhanced SAFSTOR
1008022	11/03	Industry Survey of Radioactive Material Control Practices
1008924	7/03	2003 NEI/EPRI Decommissioning Forum
1009409	4/04	Proceedings – License Termination Plans and Final Site Release Workshop
1009410	3/04	Capturing Historical Knowledge for Decommissioning of Nuclear Power Plants – Summary of Historical Site Assessments at Eight Decommissioning Plants
1009411	4/04	Decommissioning License Termination Plan Documents and Lessons Learned – Summary of LTPs for Two Reactors and NRC SERs for Three Nuclear Power Plant LTPs
1009571	8/04	Application of Non-Nuclear Robotics to Nuclear Industry Decommissioning
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1009799	9/04	Characterization of a Decommissioned PWR Vessel Internals Material Samples
1009817	5/04	Proceedings – 2003 ASME/EPRI Radwaste Workshop
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NUREG 1507	December 1997	Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various contaminants and Field Conditions
NUREG 1549	July 1998	Decision Methods for Dose Assessment to Comply with with Radiological Criteria for License Termination
NUREG 1575r1	August 2000	Multi-Agency Radiological Survey and Site Investigation Manual (MARSSIM)
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NUREG 1640v1&2	December 1998	Radiological Assessments for Clearance of Equipment and Materials from Nuclear Facilities
NUREG 1700r1	April 2003	Standard Review Plan for Evaluating Nuclear Power Reactor License Termination Plans
NUREG 1713	November 2001	Standard Review Plan for Decommissioning Cost Estimates for Nuclear Power Reactors - DRAFT
NUREG 1717	June 2001	Systematic Radiological Assessment of Exemptions for Source and Byproduct Materials
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Decontamination of Water Cooled Reactors	TRS No. 365 (1994)
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Safe Enclosure of Shutdown Nuclear Installations	TRS No. 375 (1995)
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APPENDIX

This appendix provides a listing and brief summary of each of the ComEd Nuclear Deccommissioning Plans that were reviewed for use in the development of this experience report. The specific plans themselves remain Exelon documents and not available for distribution. This document provides summarized information only.

NDP - 100 - Announcement of Permanent Shutdown Decision

This plan provides a discussion for needed internal and external communications from the time a decision to shutdown a facility is made through the first few weeks. The communications are focused on people at the affected site, employees at other business units, media, political leaders, community leaders, regulators and stockholders.

NDP - 201- Unit Shutdown

This plan will provide:

- potential impacts and considerations for achieving a safe and event-free shutdown
- a recommended shutdown strategy
- recommendations for schedule development

The site management is responsible for safety and for operations of the facility. This plan does not provide either direction or detailed actions to be taken on a unit shutdown. Site procedures for unit operation, schedule development, and work deployment will govern these activities.

NDP-202 - Unit Defueling

This plan provides a guide for factors to consider when developing a defuel schedule for permanent shutdown. The scope of this plan is to provide the site with:

- a recommended strategy for defueling the reactor(s)
- principles for schedule development
- a standardized list of pre-defueling activities to input to schedule development
- other considerations due to the change in facility status

The site management is responsible for safety and for operations of the facility. This plan does not provide either direction or detailed schedules for unit defueling. Site procedures for unit operation, schedule development, and work deployment will govern these activities.

NDP-203 - Independent Oversight of Plant Activities

The purpose of this plan is to implement an independent oversight function in support of safe, event-free shutdown and defueling of the units.

The Independent Oversight Teams are responsible for conducting overviews of operating and maintenance activities that could potentially impact nuclear safety to assure the following:

- sharp focus on nuclear safety is achieved for all plant activities
- management standards and expectations are implemented
- activities are effectively communicated to individuals
- environment is conducive to safe plant operations
- personnel are fit-for-duty
- appropriate inputs are considered in the decision-making process

NDP-204 - Allegation Management

The scope of this work plan is to describe the process for allegation management to support timely and effective resolution of employee issues.

NDP-206, Transition Team Process , Responsibilities, and Interfaces

This plan describes the process for the Transition Team that supports the site in the deployment of career transition, shutdown organization selection, trauma management, oversight, quality issues management, and process transition activities. The plan clarifies roles and responsibilities and interfaces of the Transition Team and the site organization.

NDP-301 - Internal Human Resource Plan

- This plan discusses the following activities during the organizational transition:
- Employee communications
- Employee assistance and career counseling
- Staffing the decommissioning organization
- Career transition activities and severance benefits
- Short-term retention and severance benefits
- Long-term retention program
- Labor strategy
- Out-processing of employees
- Trauma management for affected site
- Survivor Plan for Non-affected sites

NDP-302 - Review and Completion of Contractor Activities

The scope of this plan is to review contractor activities and determine which contractors are essential to the immediate operational needs of the station and to furlough or terminate contractors not immediately required. .

NDP-302 - Out-processing of Furloughed or Terminated Contractor Personnel

The scope of this plan is to efficiently outprocess contractors who have been furloughed or terminated as a result of a decision to permanently shutdown a nuclear facility.

NDP - 401 - Organizational Transition Phase Security Plan

This plan provides for enhanced security measures to support shutdown, defuel and transitional activities as a result of a decision to permanently cease operations.

NDP - 402 - Data and Information Systems Security

This plan provides measures to be taken to secure critical databases and computer systems from unauthorized use.

NDP - 403 - Security Plan Revisions for Change in Facility Status

This plan provides factors to be considered to revise the site security plan for:

- Fitness For Duty requirements
- Security organization for armed/unarmed security activities
- Changes to intrusion detection systems
- Preventative maintenance requirements
- Access authorization
- Vital area reduction based on part 100 release for permanently shutdown plant

NDP - 404 - Long-Term Spent Fuel Storage Security Plan

This plan provides factors to be considered to revise the security plan for long-term spent fuel storage options (wet versus dry IFSFI), and revisions as a result of changes to potential part 100 release scenarios.

NDP - 501 - Regulatory Activities - Organizational Transition Phase

This plan addresses licensing submittals to be issued to the NRC or under review by the NRC, and communications with the NRC and IDNS. It does not include dispositioning pending regulatory responses, such as the response to a NRC violation.

The objectives of this plan are the following:

- Submit the required notifications to the NRC for permanent cessation of operations and fuel removal from the reactor vessels.
- Obtain NRC approval of the transfer of responsibility for the facility, once permanently defueled, from the Nuclear Operations Division to Corporate Services.
- Communicate with the NRC and IDNS at specified stages in the deployment of the shutdown decision to keep them informed of progress and future actions.
- Revise certain programs based on the permanently defueled condition of the plant.
- Identify pending NRC licensing actions that can be deferred or deleted and disposition them with NRC concurrence.

NDP - 502 - Medium Term Regulations Activities Plan

The purpose of this plan is to provide guidance regarding the preparation of a Post Shutdown Decommissioning Activities Report (PSDAR). The PSDAR is one of the three submittals that must be completed within the first two years following the permanent shutdown of a nuclear power plant - the PSDAR, a site-specific Decommissioning Cost Estimate, and Program to Manage and Provide Funding for the Management of Irradiated Fuel.

NDP - 601 - System Characterization and System Information Turnover

The primary actions to be accomplished by this work plan are as follows:

System Characterization: System Characterization consists of the capture of critical system knowledge including the current status of the system prior to the existing System Engineering staff leaving the site or being reassigned. This additional information will be added to the System Notebooks. The focus will be on “OPERABLE” and “Functional” systems. System Characterization will also be performed on “Not Required” systems, however this effort will be limited to compiling existing, easily retrievable information.

System Information Turnover: Once the System Characterization has been completed and the information added to the System Notebook, that system shall have a formal information turnover to the oncoming Decommissioning System Engineer. The turnover will consist of:

- System walkdown (preferred, not mandatory)
- Interaction time including review of radiological characterization information for the system
- System information turnover meeting

The completion of the system information turnover indicates that the Oncoming Decommissioning System Engineering Staff is ready to take responsibility for that system.

NDP - 602 - Required Equipment Status and Initial USFAR Revisions for a Shutdown Plant

The scope of this plan is as follows:

- UFSAR revisions
- Safety evaluation procedure revisions
- Required Equipment Status (RES) designation

The Master RES Reference Document is intended to be used as reference tool for input into the decision making process when evaluating changes in plant configuration, processes and procedures. It must be recognized that the Licensing Basis and Design Basis may not yet be revised to reflect the permanently shutdown and defueled status of the unit. Therefore, caution must be exercised to address the governing Licensing Basis, Design Basis and current plant conditions when evaluating proposed changes, including safety evaluations.

NDP - 603 - Disposition of Open Work Items

The primary action to be accomplished by this plan is for the outgoing system engineering staff to disposition Outstanding Work Items (OWIs) on plant systems, to the extent practicable, prior to their permanent release. All OWIs listed in the System Characterization and System Information Turnover Package will be reviewed to determine if the OWI should be: 1) completed as planned, 2) canceled, or 3) revised, deferred, or changed in scope. Criteria for this review is contained in this work plan. Execution of this work plan should not proceed until the Master Required Equipment Status Reference Document is approved for use.

NDP - 604 - Configuration Management Process for a Shutdown Plant

This plan provides for the development and approval of a defueled FSAR that will be the new design basis of the plant. In addition, other outputs from this plan are:

- Re-classification of systems
- Revised Master Equipment List (MEL)
- Revised “Q-List” (quality requirements) for systems remaining operable or functional

The procedure(s) that are developed from the direction of this plan will be the configuration management process from which modifications and changes are made to plant systems, structures, and components.

NDP - 607 - Drawing Control for Dismantlement and Abandonment Activities

This plan delineates the requirements for drawing changes and control during dismantlement and abandonment activities.

NDP - 608 - Dismantlement Support - Site Modifications

This plan provides guidance on modifications that should be initiated to support decommissioning activities. Examples of support modifications are upgrades to cranes and utilities, temporary systems to allow area/system dismantlement, etc. This plan would also include modifications needed for a wet ISFSI or dry cask storage depending on which option is chosen.

NDP - 609 - Dismantlement Support - Radiological Controls

This plan provides guidance on modifications to support radiological controls and processes needed for dismantlement activities such as temporary waste processing facilities, tank desludging, removal of high dose components, etc.

NDP - 610 - Technology Application

This plan provides a menu of technology options that can be applied across all decontamination and dismantlement functions. The plan will contain reference electronic sources of information that are routinely updated as technology changes. Successful technologies tested and proven during full scale decommissioning projects will be described in this plan for use by the decommissioning manager in choosing the most effective and cost efficient option.

NDP - 701 - Disposition of Investigations and Corrective Actions

The scope of this work plan is to define the method for disposition of open investigations and corrective actions that are contained in the commitment tracking system. Significant regulatory commitments, e.g., responses to 10CFR50.4(f) letters or Confirmatory Action Letters, which have not yet been completed, should be addressed in a separate effort

NDP - 702 - Close - Out of General Department Work

The purpose of this plan is to provide a process to disposition general departmental work activities for a plant that is permanently shutdown. The work activities addressed are the routine or on-going work activities of the functional areas such as reports, meetings, and administrative functions. The plan includes criteria for the disposition of on-going activities, methods to accomplish the reviews, responsibilities, and documentation.

NDP - 703 - Training Plan

The purpose of the training work plan is to provide a process for transitioning the training programs to the needs of a permanently shutdown plant. The objectives of the work plan for the first 90 days are to maintain the requirements of 10CFR55 (Operator Licenses) and 10CFR120 (The Training Rule) until license exemptions are in place, and to train the new organization on changes due to the permanent shutdown of the plant such as regulatory requirements, tech spec changes, and organizational roles and responsibilities.

The plan also addresses those activities and tasks needed to be initiated during the first 90 days to support the transition to the shutdown organization. Four topical areas are addressed:

- Disposition of training, training development, and training process activities.
- Technical training that needs delivery prior to the shutdown organization assuming responsibility for the site.

- Organization roles and responsibilities training for the shutdown organization that is required prior to assuming responsibilities for the site.
- Training development activities to be done during the first 90 days in support of training activities post 90 days.

NDP - 704 - Organizational Development Strategy

The objective of an OD/change strategy is to provide a guide for managing the human and social dynamics of transitioning to a shutdown organization. This will be achieved through a partnership between the Senior Management (of the shutdown organization) and the OD change representative, with the intent of maximizing performance while minimizing unintended repercussions of the change. A secondary objective is to begin forming the new organizational culture.

NDP - 705 - Organizational Transition Turnover Process

There are three purposes of this turnover process:

- Transfer of knowledge from the current organization to the Shutdown Organization on plant and personnel issues
- Provide a process for the new organization to become cognizant of plant and equipment status
- Perform assessments of critical processes and activities to provide reasonable assurance that the changes in organization structure and people, due to the transition, will not impact the new organization’s ability to safely store fuel.

NDP - 706 - Review Committees

This plan provides for the establishment of a Decommissioning Review Committee (DRC) and a Overview Board. The DRC provides an independent review of items similar to those currently reviewed by the on-site review and off-site review (or Plant Operations Review Committee) functions. In addition, the Overview Board reviews site events, plans, and overall performance.

NDP - 707 - Plant Records Retention

The purpose of the plan is to provide sufficient instructions and direction to allow for the capture of the required plant records. The necessary records need to be centralized and consolidated and those generated during the decommissioning process collected and retained. The records will need to be prioritized and dispositioned depending on their type and usefulness.

NDP - 708 - Investment Recovery

The purpose of this plan is to provide a process to disposition plant assets (material, equipment, supplies, land, structures, etc.) that are no longer needed so that salvage/resale value is maximized and disposal costs are minimized.

NDP - 709 - Public Relations

The scope of this plan is to review the financial impact to local communities in the event of a closure of a nuclear station. It will identify probable negative impacts that could arise in such a decision, and will make recommendations to help in the mitigation of these issues. The objectives for this plan are:

- Review the impact a decrease in real estate taxes will have on the surrounding communities
- Review long term actions that the company can take to help off set the negative impact associated with a decrease in tax revenues
- Consider what impact a closure decision will have on local civic groups that rely on financial contributions
- Review the need for a community advisory board to discuss issues dealing with the decommissioning process

NDP - 801 - Project Management Process

This plan provides the project management tools that will be used through-out the project. The tools are software, procedures, reports, responsibilities, and processes for the following project management functions:

- Planning
- Scheduling
- Cost Control
- Performance Monitoring

NDP - 802 - Scheduling

This plan provides guidance on sequencing and logic ties for decommissioning activities using input from industry decommissioning experience and contractor input.

NDP - 803 - Decommissioning Cost Management

This plan provides the methodology and process to perform cost estimates for dismantlement activities by area (opposed to by system) and using the cost estimates to establish the project budget.

NDP - 804 - Construction/Deconstruction Organization

This plan established the contractor organizational structure and standards by specifying:

- staffing levels
- qualifications
- work hours

- communication standards
- safety standards
- interface document with site organization

NDP - 901 - Waste Disposal Management

The scope of this plan is as follows:

- Provide a process for waste categorization and estimation of waste volumes
- Determine the roles and responsibilities for decontamination, volume reduction, waste handling and packaging, and waste shipment within the shutdown organization
- Provide the process for reducing the volume of radioactive and mixed waste by:
- Determining what materials should be sent to a waste processor or decontaminated/volume reduced on site
- Determine the optimal shipping containers (and methods of dismantlement) to minimize shipments and meet DOT and NRC transport regulations
- Establishment of on-site waste handling facilities
- Providing direction for activation analysis and cost analysis for large component removal (reactor vessel and internals) and
- Provide direction in establishing cost effective waste processing, shipment, and burial contracts with vendors

The outputs from this plan will be used as inputs to the PSDAR (Waste Volume and Cost Estimates) and as a basis for budget and cost control tools for the project management process.

NDP - 902 - Hazardous Materials Disposal

The scope of this plan is as follows:

- Define responsibilities for RCRA, TSCA, and CERCLA regulations (40 CFR) within the shutdown organization
- Provide a process for sampling, analysis and characterization of hazardous waste on-site
- Process for handling, packaging, and burial of hazardous waste such as asbestos, lead, PCBs, mercury, chromates, etc.

NDP - 903 - System Decontamination Decision Analysis

This plan provides a methodology to perform a decision analysis to determine if a system decon is necessary, from a cost exposure perspective for dismantlement activities. The plan also provides a methodology for determining if more aggressive decon solutions can be used on a decommissioning project and be able to dispose of the decon solution waste.

NDP - 1001 - Site Characterization - Initial Data Collection

The purpose of this plan is to provide sufficient instructions and direction to follow for the initial evaluation of existent hazards (radiological and non-radiological) including any requisite sampling approaches necessary.

Included in this plan is the Historical Site Assessment (HSA) which identifies potential sources of radioactive material and hazardous (chemical) contaminants. The HSA is similar to the "Scoping Survey", defined in NUREG/CR-5849 that provides the basis for initial estimates of the level of effort required for decommissioning and for planning the characterization survey. The HSA utilizes existing records and data and interviews with the plant staff.

NDP - 1002 - Long Term Hazards Evaluation

This plan provides guidance on surveys and monitoring beyond those currently conducted that are needed during the decommissioning process to support the final site survey. The plan describes the generalities, and sampling (core bores or test wells) for final site survey.

NDP - 1003 - Final Site Survey

This plan is a roadmap to be used by the decommissioning radiation protection manager to develop detailed procedures for conducting a final site survey.

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