Experiences with the Transition from Operation to Decommissioning at NPPs on the U.S.

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Presentation Topics

- What is the Transition Period?
- Why is the Transition Period Important?
- Summary of Transition Period Regulations
- Summary of U.S. Transition Period Experiences
- What Should You Do?
What is the Transition Period

- Generally defined as the period from the permanent shutdown of the NPP until major dismantlement in radiological control areas (RCA) begins
- Regulatory prerequisites to major dismantlement activities vary from country
  - In U.S., major dismantlement can begin
    - Once defueled safety analysis report and revised plant design basis has been approved by the regulator
    - Dismantlement in the RCA often begun while spent fuel is still in spent fuel pool once shown to meet regulations
  - In many other countries, major dismantlement in the RCA cannot begin until:
    - Decommissioning License granted by the regulator
    - All spent fuel has been removed from the plants’ spent fuel pool
Why is the Transition Period Important (1/2)

- Transition is a period of great change at an NPP
  - Human Factors:
    - Employees concerned with their future
      - How long will I have a job
      - Should I be seeking employment consistent with my experience
    - Management needs to maintain qualified staff despite many employees wishing to leave their positions
  - Nuclear Safety:
    - Plant procedures, Technical Specifications and equipment operability must be maintained until engineering/licensing process for elimination or system downgrading has been completed
    - As nuclear safety requirements are greatly reduced during decommissioning, site culture changes to more of a construction site mentality
- All these changes can be a great distraction to the plant workforce
  - Having a Human Resources Plan in place can be a great help to reduce this distraction/employee anxiety
  - A Communication Plan can inform the workforce and other stakeholders
Why is the Transition Period Important (2/2)

- Costs during the transition period can be very high
  - EPRI Study Conclusion: Cost of decommissioning in the US is highly influenced by overall staffing costs, which is directly related to the overall length of decommissioning ($300,000 total decommissioning cost/day quoted by a site).

![Cost Categories as a % of Total Cost]

- Approximate staffing costs during transition period in US - $25 Million/year
- Recent Experience in the US is to minimize the length to the Transition Period
What Happens During the Transition Period?

- A wide range of key activities are necessary after permanent shutdown of a nuclear power plant before active dismantlement of the plant can begin.

- In some cases these transition activities may be:
  - Prescribed by regulation, or
  - Practically driven or even optional.

- In either case, it is often unclear what activities are needed and when/how those activities should be conducted to most efficiently transition from operational to decommissioning status.

- EPRI recently completed a project which develop guidance for transitioning from normal operation to decommissioning
Typical Goals During Transition Period in the US

- Maintain the Safety of the Plant including the Spent Fuel
- Reduction in Technical Specifications
- Reduction in Operating Systems
- Reduction/Modification of Necessary Programs
- Eliminate Need for Off-site Emergency Plan
- Perform Early Decommissioning Projects such as:
  - Disposition Operational Waste
  - Full System Chemical Decontamination
  - Asbestos Insulation Removal
  - Modify Building Containing Fuel Pool to Spent Fuel Pool Island (SFPI)
- Begin Planning for Long Lead Time Decommissioning Projects
EPRI Project Overview

- Country-specific transition period regulations & experiences compiled for US, Germany, France, Spain, and Switzerland
  - Required transition activities identified
  - Cost-saving transition activities identified
  - Long-lead transition activities identified
  - Transition activities that can be proactively conducted during operation identified

- Guidance developed for the following scenarios:
  - Transitioning to DECON for planned shutdown
  - Transitioning to SAFSTOR for planned shutdown
  - Transitioning to DECON for unplanned shutdown
  - Transitioning to SAFSTOR for unplanned shutdown

- Guidance developed for operating plants to minimize impact of unplanned shutdown
Transition Period Regulations
US Transition Regulations (1/3)

- US plants do not have to apply for a formal decommissioning license after permanent shutdown, unlike some other countries.
- Decommissioning process structured around several regulatory submittals.
US Transition Regulations (2/3)

- Many regulatory submittals and engineering/licensing activities needed before major dismantlement can begin
  - Definition of accidents applicable during decommissioning
  - Analysis of consequences of decommissioning accidents
    - Off-site dose consequences
    - Determines safety related systems, structures and components (SSCs)
  - Safety Analysis Report revised to Defueled Safety Analysis Report
    - Describes decommissioning accidents and consequences
    - Revises Plant Design Basis:
      - Safety Related SSSs
      - Description of abandoned systems removed
  - Technical Specifications revised to include only those related to the functions safety related systems
  - Other Major Engineering/Operations Activity:
    - System Downgrade Process
      - System Value Line-up and Tagout
      - Systems placed in lowest achievable energy state (drained, disconnected)
US Transition Regulations (2/2)

- Many regulatory submittals are not strictly required during the transition to decommissioning, but are cost effective
  - Permanently Defueled Tech. Specs.
  - Security Plan Exemptions
  - Rescission of NRC Orders
  - Decom. Trust Fund Access Exemption
  - Insurance Exemptions
  - Certified Fuel Handler Training Program
  - Decommissioning QA Plan
  - Records Retention Exemption
  - Removal of License Renewal Conditions
Typical International Transition Regulations

- Unlike US, after permanent shutdown a specific decommissioning license is needed before major decommissioning activities permitted
  - To obtain license, plants must demonstrate adequate technical and financial capabilities to conduct the decommissioning
  - During transition period, plants may conduct activities covered by the normal operating license (including decontamination, disposal of operational wastes, etc.)

- Review and approval of the license application typically takes 3-5 years
  - Development of decommissioning license application may take >2 years
  - For unplanned shutdowns, transition period durations >5 years common

- In some countries, dismantling activities cannot begin until all fuel is removed from SFP
Transition Period Experiences
US Transition Period Experiences

- 8 US transition period experiences summarized
  - Focus is on Oyster Creek, CR3, Kewaunee, SONGS and VY

<table>
<thead>
<tr>
<th>Plant Name</th>
<th>Shutdown Date</th>
<th>Initial Decommissioning Strategy</th>
<th>Months of Decommissioning Preparation</th>
<th>Transition Period Duration</th>
<th>Current Status</th>
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<tbody>
<tr>
<td>Connecticut Yankee</td>
<td>Dec-96</td>
<td>DECON</td>
<td>0</td>
<td>2.8 Years</td>
<td>ISFSI Only</td>
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<td>Maine Yankee</td>
<td>Aug-97</td>
<td>DECON</td>
<td>8-20</td>
<td>1.8 Years</td>
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<td>Zion 1</td>
<td>Feb-98</td>
<td>SAFSTOR</td>
<td>1</td>
<td>2.4 Years</td>
<td>DECON</td>
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<tr>
<td>Zion 2</td>
<td>Feb-98</td>
<td>SAFSTOR</td>
<td>1</td>
<td>2.4 Years</td>
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<tr>
<td>Oyster Creek</td>
<td>Jan-00</td>
<td>DECON</td>
<td>33</td>
<td>N/A</td>
<td>Normal Operation</td>
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<tr>
<td>Crystal River 3 (CR3)</td>
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<td>SAFSTOR</td>
<td>0</td>
<td>2.4 Years</td>
<td>SAFSTOR</td>
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<tr>
<td>Kewaunee</td>
<td>May-13</td>
<td>SAFSTOR</td>
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<td>SAFSTOR</td>
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<td>San Onofre 2 (SONGS 2)</td>
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<tr>
<td>San Onofre 3 (SONGS 3)</td>
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<td>0</td>
<td>4.1 Years</td>
<td>DECON</td>
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<tr>
<td>Vermont Yankee (VY)</td>
<td>Dec-14</td>
<td>SAFSTOR</td>
<td>16</td>
<td>1.3 Years</td>
<td>SAFSTOR</td>
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</table>

Correlation between transition period duration and months of preparation is evident
US Transition Period Experience

Example – Connecticut Yankee Transition Period Timeline

- Power Operations
- Detueling
- Permanent Shutdown
- Permanent Shutdown Announced To NRC
- Initial Decommissioning Planning/Site Scoping Survey
- Improved Health Physics Program Development
- PSDAR Submitted
- Decommissioning Public Meeting
- Initial Site Characterization and Historical Site Assessment
- Bulk Asbestos Insulation Removal
- DSAR Submitted
- Full System Chemical Decontamination
- Operating License Amended to Reflect Permanent Shutdown
- Fuel Building Upgrades Completed
- Subcontract to Decommissioning Operations Contractor
- Steam Generator/Pressurizer Removals *
- Operating License Amended to Reflect Decommissioning *
- Reactor Pressure Vessel Internal Segmentation Project *
- License Termination Plan Submitted *
- Site Characterization Report Submitted to NRC *

*Work to support activity possibly begun during transition period
US Transition Period Experience

Example – Exelon Nuclear Mgmt. Model Transition Period Timeline

*Initial Plant Only – Management Model Addition

** PSDAR Submission Tied to Strategy Approvals; PSDAR Does Not Require NRC Approval, DCE (Decommissioning Cost Estimate) for PSDAR plan will be submitted with or shortly after PSDAR submittal. No approval required for DCE.
Major US Transition Period Activities (1/2)

- Preparation of Regulatory Submittals
- Historical Site Assessment (Radiological & Non-Radiological)
- Initial Site Characterization
- Disposal of Operational Wastes
- Cool and Dim / Cold and Dark Program
- Develop Communications Plan
- Transition to Decommissioning Organization and Staffing
- Spent Fuel Management
  - Modify Building Containing Fuel Pool to Spent Fuel Pool Island (SFPI)
  - Move Control Room
  - Collapse Security Boundary to SFPI
  - Independent Spent Fuel Storage Installation Design / Permitting / Construction
Major US Transition Period Activities (2/2)

- Full System Chemical Decontamination
- Hot Spot Removal
- Hazardous Material Removal (Asbestos, flammable material, etc.)
- Dismantling of Non-Nuclear Facilities
- Planning for Major Decommissioning Engineering Challenges
  - Major Component Removal
  - Reactor Vessel and Internals Segmentation
EPRI Transition Period Guidance
What Should You Do?

- Begin planning for decommissioning at least 3 years prior to the date of permanent shutdown
- Create decommissioning planning team during operation
  - Relieve planning team members of operational duties
  - Decommissioning planning team tasks:
    - Review applicable regulations
    - Review decommissioning experiences and available guidance
    - Visit decommissioning sites
    - Work with industry experts
    - Prepare Decommissioning Regulatory Submittals and Submit to Regulator
      - Many regulatory submittals will not be significantly affected by short term plant operations or changes to decommissioning plans
    - Develop plans that address critical decommissioning issues/questions
      - Human Resources Plan
      - Communication Plan
      - Decommissioning Strategy (Future Site Use, Prompt/Delayed Decommissioning)
- Get involved in decommissioning regulation development / revision process
- Maintain comprehensive historical site assessment during normal operation
Example US Transition Plan (Unplanned Shutdown to DECON)

- Power Operations
- Certification of Permanent Shutdown to NRC
- Defueling – Cert of Permanently Defueled
- General Decommissioning Planning
- ISFISI Planning and Permitting
- Rad & Non-Rad HSA Development & Completion
- CFH Training Program
- TS Amendment - Admin Controls
- Emergency/Severe Weather Security Exemption
- Permanent Shutdown Emergency Plan (PSEP)
- DSAR, Accident Analyses, SSC Recategorization
- PSAR Prep & Submittal
- Site-Specific DCE Prep & Submittal
- IFMP Prep & Submittal
- Implement SFPI
- Establishment of Cool and Dim Conditions
- Flammable Material Removal & Transition to IFB
- DTF Access Exemption Request
- TS Amendment - PDTS
- EP Exemption Request / POEP
- Requests for NRC Orders Rescission
- Initial Site Characterization (Rad & Non-Rad)
- Asbestos Removal
- Defueled Security & Cyber Security Plans
- On-site Insurance Exemption Request
- Off-site Insurance Exemption Request
- Decommissioning QA Plan
- Spent Fuel Decay Milestone (10-150 to Zirc. fine)
- Full System Chemical Decontamination
- Hot Spot Reduction
- ISFISI Construction
- Implement POEP
- Major Decommissioning Activities
- ISFISI Only EP, TS, DSAR, QAP, Security Plan
- Spent Fuel Transfer to ISFISI

Access to 3% of Generic DTF Amount
Example US Transition Plan (Planned Shutdown to DECON)

-3 -2 -1 0 1 2 3

Years from Permanent Shutdown

- Certification of Permanent Shutdown to NRC
- Rad & Non-Rad HSA Development & Completion
- Develop USAR Inputs (SSC, Recategorization, Accident Analyses)
- IS Amendment - PDEP
- Detailed Security & Cyber Security Plans
- Requests for NRC Orders Rescission
- Emergency/Severe Weather Security Exemption
- CFH Training Program
- Site-Specific DCE Prep & Submittal
- Permanently Shutdown Emergency Plan (PSEP)
- Decommissioning QA Plan
- Initial Site Characterization (Including Non-Rad)
- EP Exemption Request / PDEP
- PSDAR Prep & Submittal
- IFMP Prep & Submittal
- DTF Access Exemption Request

- ISFSI Planning and Permitting
- On-site Insurance Exemption Request
- Off-site Insurance Exemption Request
- Defueling, + Cert of Permanently Defueled
- Implement POTS, CFH, DQAP, Security Plan
- DSAR
- Full System Chem Decon
- Implement SFPI
- Establishment of Cool and Dim Conditions
- Flammable Material Removal & Transition to IFB
- Asbestos Removal
- Dismantling of Non-Rad Systems and Structures
- Hot Spot Reduction
- Major Decommissioning Activities
- Spent Fuel Decay Milestone (10-hrs to Zirc. fire)
- Implement PDEP
- ISFSI Construction
- ISFSI-Only EP, TS, DSAR, QAP, Security Plan

Access to 3% of Generic DTF Amount

~1.3 Year Transition Period

Complete Access to DTF

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EPRI Transition Period Guidance Summary

- Specific guidance is provided for each major transition period activity in the report
- Example transition plans provided for transitioning to DECON and SAFSTOR for both planned and unplanned shutdown
- Decommissioning guidance for operating plants is provided to help minimize impact of unplanned shutdown
- References to prior regulatory submittals
EPRI Transition Period Guidance Report Summary

- **Status:**
  - Reviewed by NEI/Utility Decommissioning Transition Working Group and international EPRI Decommissioning Program members:
    - Recent experiences added to the report
    - Utility comments have been incorporated
  - Report available to EPRI Program Members as *Guidance for Transitioning from Operation to Decommissioning at Nuclear Power Plants*, Report # 3002007551
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